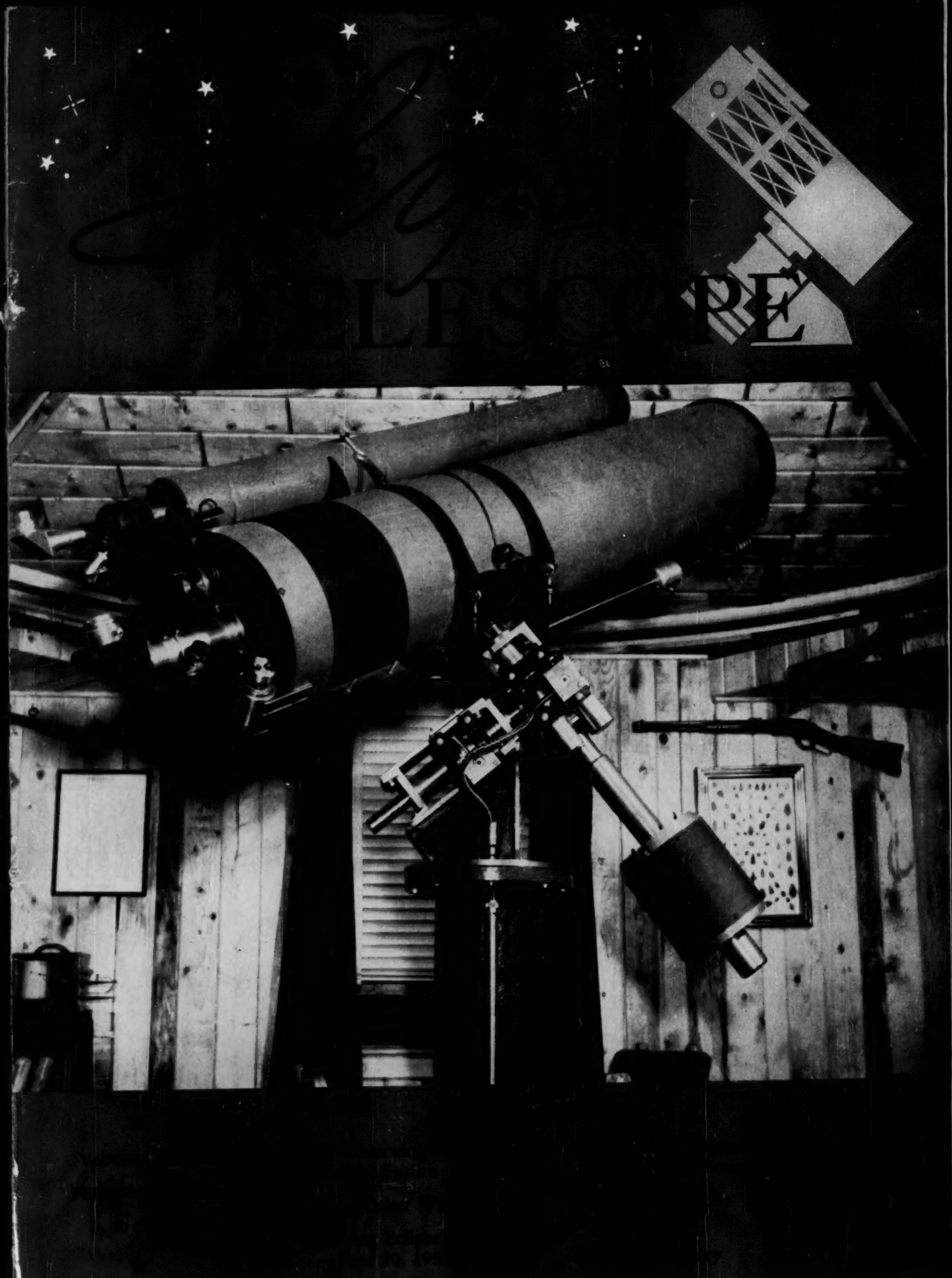
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Sky and TELESCOPE

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Vol. XIV, No. 4 FEBRUARY, 1955

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The Pole of Rotation of Venus

VISUAL OBSERVERS often report faint and elusive dusky markings on the glaring bright disk of Venus, but as early as 1898, W. Villiger showed that these impressions were largely subjective. Illuminated plaster models of the planet apparently bore similar dark markings; they were of physiological origin.

This work invalidated G. Schiaparelli's earlier conclusion, based on extensive observations of Venus' dusky features, that the planet rotated in the same 225-day period that it requires to complete the circuit of its orbit.

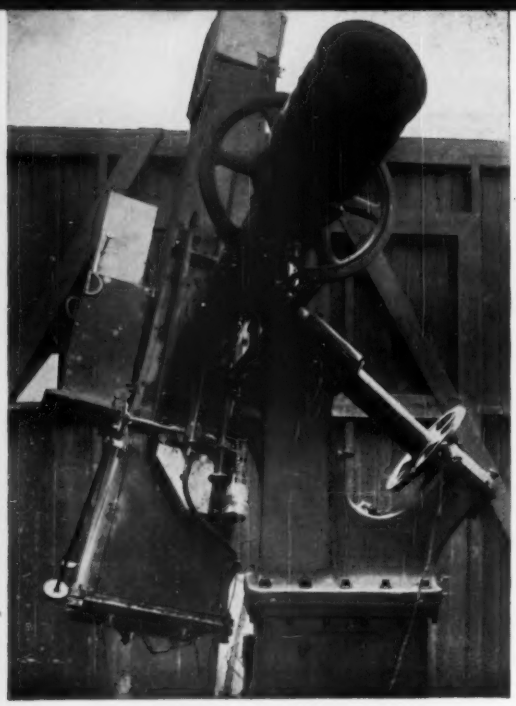
With the 60-inch Mount Wilson reflector, however, F. E. Ross found abundant bright and dark cloud formations that were conspicuous on ultraviolet photographs, weak in blue light, and invisible in red and infrared light. These features were so transitory that a rotation period could not be deduced from them.

The latest photographic study of Venus is by Gerard P. Kuiper, of Yerkes and McDonald Observatories, who describes his observations in the *Astrophysical Journal* for November, 1954. Using the 82-inch McDonald reflector with an enlarging camera, he procured daytime photographs in violet light on a scale of 2.1 seconds of arc per millimeter.

In these pictures, the normal appearance of the planet is banded, as Ross' photographs had already indicated. Usually there are three bright and three dark bands, nearly perpendicular to the terminator (the edge of the sunlit portion of the planet's disk). On April 8, 1950, with excellent seeing, there were eight bright and dark bands. Photographs secured in June and July, 1954, confirmed this banded structure, which Dr. Kuiper attributes to zones of ascending currents (dark) and descending currents (light) in a relatively simple circulation pattern in Venus' atmosphere. The Yerkes astronomer thus interprets the dark bands as elevated portions of an underlying dust-laden layer.

The banded markings, on the plausible assumption that they are parallel to the planet's equator, were used by Dr. Kuiper to make the first reliable determination of the location of the pole of rotation of Venus. Preliminary measures were made by ruling bands on a white globe to simulate Venus, and this globe was then tilted until the orientation of the bands matched those on the photographs. Further computations place the

(Continued on page 141)



Catalogue cameras like this one, which operated for several decades at Yale Observatory, are used to determine photographic star positions. Recently, improved cameras have been set up, both at New Haven and at Yale's station in Australia.

Basic Observing Programs and the Future

JOHN B. IRWIN, *Goethe Link Observatory, University of Indiana*

ASTRONOMY is primarily an observational science. This does not mean that theoretical or experimental investigations are of secondary importance, but rather that our information concerning the stars is largely derived from observations.

In this way astronomy differs from physics or chemistry. The chemist can synthesize as well as analyze, creating something not found in nature. An astronomer is able to measure Saturn's rings and determine their constitution, and in a small way he may duplicate their physical conditions in the laboratory. But he cannot supply other planets with rings, and, in general, the physical conditions found in the stars cannot be matched in the laboratory. Thus, the astronomer's knowledge of the stars is based on his analysis of their radiation, that is, on various kinds of observations.

What can we observe concerning a star? A quick answer is the star's position, spectrum, and magnitude. And so we have the observational divisions of astrometry, spectroscopy, and photometry.

Added to these is another that I shall call "direct photography," for want of a better name; or it might be called "the relation of things." As an example, consider W. Baade's discovery that the ionized hydrogen (H-II) regions outline or mark the arms of the Andromeda galaxy, M31. A direct photograph is taken, nothing is measured; one simply looks at the plate and observes a certain phenomenon. A second example is Heber D. Curtis' many photographs of galaxies, which showed the prevalence of absorbing material in the equatorial planes of spirals and the almost complete lack of it in elliptical galaxies. Properly interpreted, this information has helped in the analysis of our own galaxy.

Let us list some of the things that can be observed in these broad fields, with some of their derivatives. Then we shall discuss briefly the basic data in each, and its needs and prospects.

Field	*Observables*	*First Derivatives*	*Higher Derivatives*
1. ASTROMETRY	Position	Precession Proper Motion	Aberration Nutation Parallax Latitude Variation Visual Binaries Astrometric Binaries
2. SPECTROSCOPY	Spectral Classification Radial Velocity Element Identification Equivalent Width Line Profiles		Spectrum Variables Spectroscopic Binaries
3. PHOTOMETRY	Magnitude Color Polarization		Eclipsing Binaries Intrinsic Variables
4. DIRECT PHOTOGRAPHY			

At Yerkes Observatory, Frank Schlesinger (1871-1943), father of modern photographic astrometry, pioneered in stellar parallax work with long-focus refractors. At Allegheny Observatory he initiated the wholesale measurement of star positions with wide-angle cameras such as the Yale instrument shown above. Later he became director at Yale.

Astrometry. Even though basic catalogues of star positions are many, the appetite of the astrometrist is not dulled, because increasingly more accurate proper motions are demanded of him. A star's proper motion is its change of position across the face of the sky, and it is determined by comparing star positions measured over a span of many years. Thus, today's proper motions depend on positions given in catalogues made many decades in the past.

The new AGK3 (third Astronomische Gesellschaft Katalog) program, discussed at the 1953 Northwestern University astrometrical conference, envisages a program on some 180,000 stars, including 14,000 reference stars to be observed with meridian circles. The work involves some dozen observatories and a total manpower of about 50 to 100 astronomers, observers, technicians, and computers.

So large an effort is not even approached in other basic fields, and yet it seems necessary in solving problems of stellar motions and galactic structure. The photoelectrician can only wish that a fraction of this effort could be put into the now wide-open field of basic photometry. The AGK3 program, however, is only a practical compromise between what we would like to have and what we are able to do. From the viewpoint of the astronomer of 2000 or 2050 A.D., star positions more precise are needed *at the present time.*

In the later Yale zone catalogues, 17-

by-17-inch photographic plates were used in South Africa, with a Ross camera of seven feet focal length. Each plate covered nearly 11 by 11 degrees, and an average of eight stars was observed per square degree. The probable error of a single observation — one image on one plate—was about 0.15 second of arc, and each catalogue position, from two overlapping plates, had an error of about 0.11 second.

Suppose we wished to reobserve the whole sky with much higher precision. Twice the focal length, modern optics, fast plates, and a good climate would reduce the probable error of a single observation to about 0.08 second. It would be well to make four exposures on each plate, reversing the plate between exposures, and reversing the telescope after the second exposure. As in the Lick program (see *Sky and Telescope*, August, 1954, page 335), a grating and additional short exposures might be used to tie the important, well-observed bright stars into the faint-star positions. With 16 exposures on each star, the probable error of a catalogue position would be about 0.03 second.

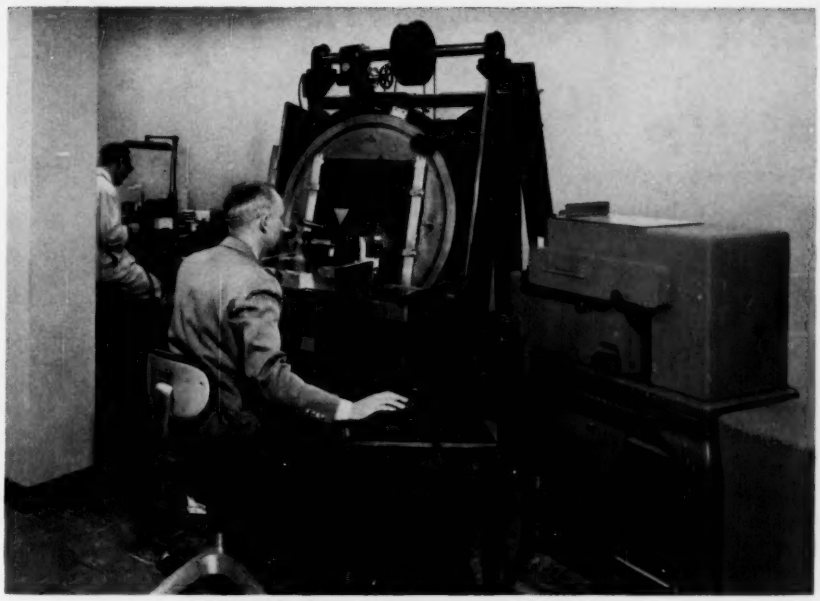
This high precision would not help us very much now in getting proper motions, for the errors of the motions would depend almost exclusively on the errors of the positions observed years ago. But the astronomers of 50 or 100 years hence would be exceedingly grateful; their proper motion errors would be only some 0.0005 second of arc per year, giving usable motions of 10th-magnitude stars. At present, the motions of most 9th-magnitude stars are drowned in accidental errors.

Given the means, this program could be carried out. It would be very lengthy: 7½ million images would have to be measured direct and reversed in both coordinates, 30 million measures in all. The new nearly automatic IBM star-measuring machine averages about one measure per minute, or 150,000 a year with a normal work schedule. One such machine would need 200 years for our program! To clean things up in 10 years many machines would be needed. The cost of the project would be millions of dollars, and it would be called production engineering as much as astronomy.

Spectroscopy. The basic observational data for spectral classification is found in the *Henry Draper Catalogue* of Harvard Observatory. Astronomy was a far different science before the publication of this catalogue a generation ago; its effect has been profound. Nowadays astronomers tend to look down their noses at basic observational programs of this type, but even the modern astrophysicist who decries "observing for observing's sake" must continually refer to the *Henry Draper Catalogue* for spectral types or the Boss *General Catalogue* to plan and assess his own observations!

The HD took only 13 years from inception to final publication, and required extremely modest telescopes. How many astronomers can say truthfully that their programs during any given 13-year period have been equally valuable?

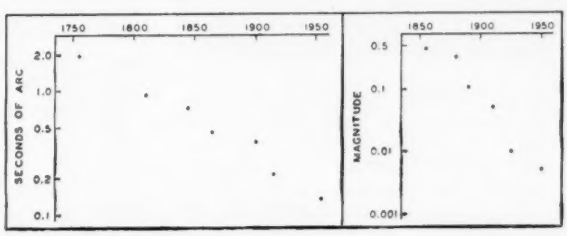
A modern HD is certainly to be desired. With present-day optics and plates and with higher dispersion, one could set up a more accurate spectral classification, plus a much-needed luminosity classification, and at the same time go to fainter stars, if necessary. The cost might run more than 10 times that of the original *Henry Draper Catalogue*.



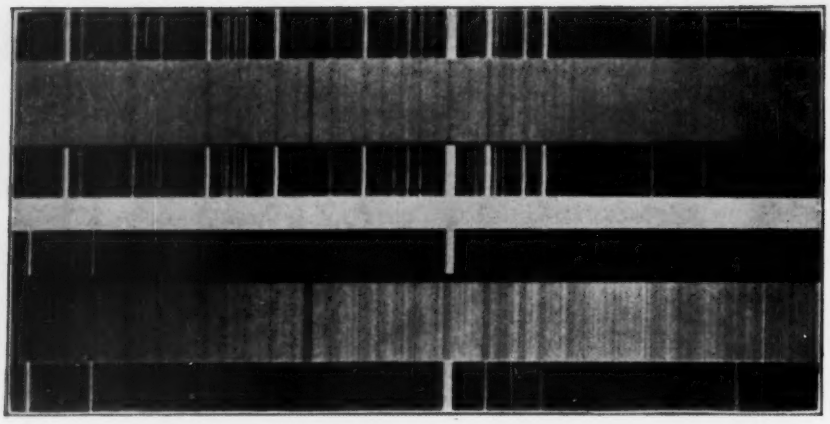
The IBM star-measuring machine is a nearly automatic means of accurately finding the positions of stars from photographic plates. A punched card tells the machine where on the plate the star is to be sought, and electric motors shift the plate until the star image is bisected with the aid of a photoelectric cell. The measured co-ordinates of the star are then punched on the card. International Business Machines Corporation photograph.

A basic radial-velocity program is of an entirely different order of difficulty. The strenuous efforts over the past 50 years of many observers, especially at the large

W. W. Campbell, director of Lick Observatory from 1901 to 1930, had earlier developed and refined the slit-spectrum method for measuring stellar radial velocities that is still standard practice 60 years later.



For star positions (left) and brightnesses, these graphs show how the accidental errors in typical catalogues have decreased with the years. The vertical scales represent probable errors of single observations.



These Yerkes Observatory spectra of the star Mizar, each flanked by comparison spectra from a laboratory source, illustrate the principle of radial-velocity measurement. Mizar is a spectroscopic binary. In the upper section, the two stars have the same radial velocity and their spectra are superimposed. Later, when one star is approaching us and the other receding, the spectrum of the first is shifted toward the violet relative to the second, and the lines appear double, as in the lower photograph.

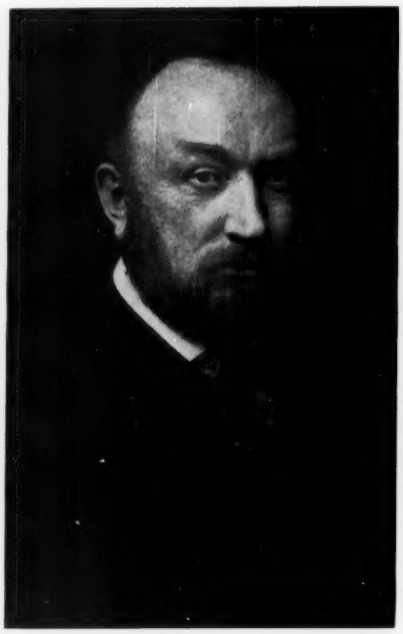
Pacific Coast observatories, have produced radial velocities of only some 15,000 stars. Furthermore, much of this effort has gone into investigations of spectroscopic binaries, a field unto itself. Almost every observatory once active in radial-velocity work has announced its intention of avoiding any further lengthy programs, despite our extremely fragmentary knowledge of the velocities of stars fainter than the 7th magnitude.

This looks like the operation of the law of diminishing returns, but new observational techniques may change the whole picture. Suppose Lallemand's photoelectronic technique *(Sky and Telescope,* September, 1953, page 286) could be applied and spectrographs some 20 to 100 times faster were built. We might then obtain slit spectrograms of 9th- or 10th-magnitude stars with a dispersion of 50 angstroms per millimeter in a minute or two, using a moderate-sized reflector. This would open the whole radial-velocity problem to reconsideration. These spectra would also yield basic luminosity data, and would reveal stars of peculiar spectra and many high-velocity stars.

Photometry. We have *no* large catalogues of stellar magnitudes and colors that even begin to meet modern needs. There are only the few hundred stars that are the Johnson-Morgan three-color fundamental standards, and another few hundred stars in the Stebbins-Whitford six-color photometry. Ultraviolet colors seem to be here to stay, and future basic photoelectric photometry should be done in at least three colors. The extensive photographic magnitude data now available is almost completely unreliable, and photographic colors are less reliable yet.

The tools are at hand for a very bright future, however. Modern photomultipliers are capable of supplying cheaply a great volume of badly needed multicolor data. Mammoth reflectors are not necessary, only good skies and intelligent instrumentation.

Let us examine the photoelectric observational problem in a very preliminary way. It would seem to be quite possible to make accurate photoelectric measures in four or more colors of the 136,000 stars brighter than magnitude 9.2 in the *Henry Draper Catalogue*. If an average of 2.5 observations per star would be enough, if stars could be observed one every two minutes, and if five *photoelectric* hours of observing per night were possible on the average throughout the year, then the northern hemisphere observations could be completed in from three to eight years. The results would be put in catalogue form as magnitudes and color indexes, with the following very conservatively estimated probable errors: blue minus violet light, 0.005 magnitude; ultraviolet minus blue, 0.010 magnitude; and for the yellow or "visual" magnitude of a star, 0.008.



E. C. Pickering, director of Harvard Observatory from 1876 to 1919, led many basic observational programs, such as the "Henry Draper Catalogue" and the measurement of the visual magnitudes of some 60,000 stars.

A reflector of the order of 30 or 36 inches aperture would be needed. This should be a very short-tube instrument with a precision drive, easy to set quickly and accurately on a star. The four or six colors would be observed simultaneously in wide bands in the focal plane of a spectroscope. An observation might consist of one or two 20-second deflections on the star and another on the adjacent sky. Very frequent comparisons with nearby standard stars would be made, but these are not yet available in sufficient number, nor in enough colors.

The year-round average of five sufficiently clear hours per night, assumed above, could be met in southeastern California or southwestern Arizona, even allowing for dust storms and cirrus clouds. The whole sky could be finished up by a moderately lengthy expedition to the Southern Hemisphere. One is reminded of the Dudley Observatory's 1909 expedition to San Luis, Argentina, where 60,000 meridian circle observations were made in one year.

This two-hemisphere program would entail reading some six million deflections from tapes. From our experience, properly trained young women can read six deflections a minute. The reduction problem is very much less severe than for the astrometric case, and it is ideally suited for punched-card machines after the tapes have been read.

Planning a Program. Before starting a comprehensive program in any of our basic fields, one should look carefully into such questions as: What are the exact purposes of the program? How long will it take? What will it cost? Will the best instrumentation be used? Is the program timely, and is there risk of its being outmoded by some new method just around the corner?

The question of purpose is perhaps the most important and the hardest to answer. Thus, a meridian circle observer in 1880 could give many apparently good reasons for his work and still have no premonition of its later applications to galactic rotation, the asymmetry of stellar motions, the zero point of the period-

luminosity law, stellar population questions, and more.

As an example of planning, a tentative list of purposes of our proposed photoelectric program would go something like this:

1. It would provide exceptionally accurate magnitude data basic to a multitude of future problems.

2. It would provide detailed knowledge of the extent, amount, and nature of interstellar reddening and absorption.

3. Many new variables and distant supergiant stars would be discovered.

4. It would separate giants and dwarfs for most spectral classes.

5. Exceptionally red and exceptionally blue stars would be discovered.

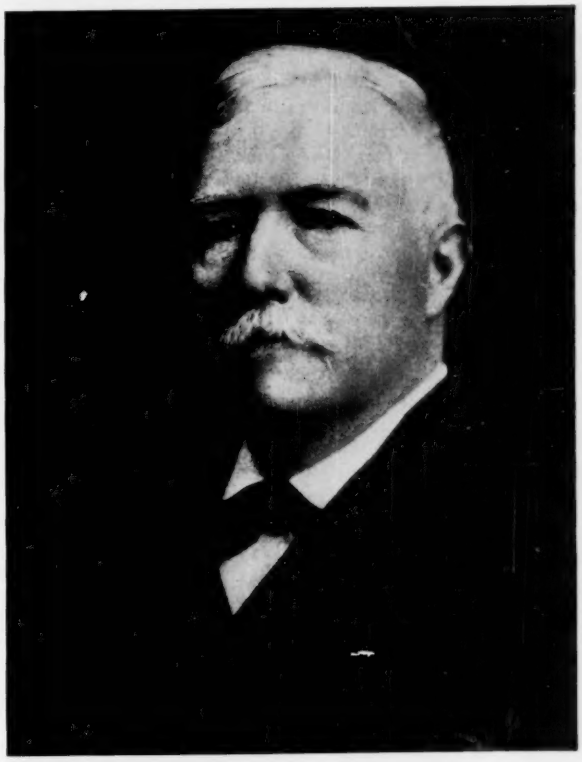
6. It would give statistics of the occurrence of variable stars within each spectral class.

7. It would yield large numbers of accurate photometric distances of stars.

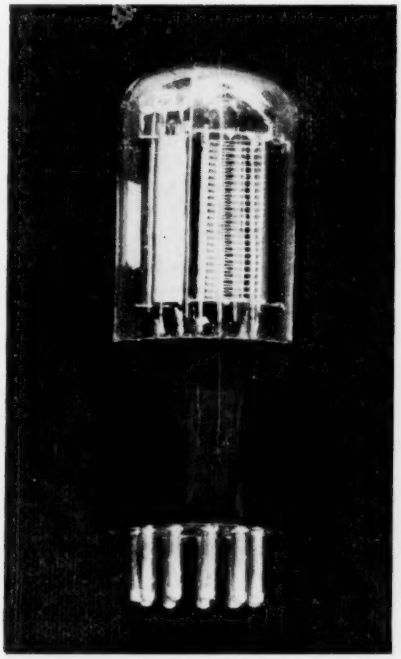
8. It would provide unusually adequate standards of magnitude and color all over the sky.

9. It would stimulate and open up many other lines of research.

Such a catalogue of photometric magnitudes would fill a large, aching void in our basic observational knowledge. It would be timely because our photocells are approaching peak efficiency, and no exceptional improvement is to be expected in the usual color regions. For most of the colors of most of the stars, the precision would depend entirely upon the quality of the atmosphere through which the stars were observed. Even if only a tenth of the observational data were later to be needed for *specific* purposes, nevertheless the statistical results would be important. Furthermore, with mass production methods, the observing could be made very efficient indeed. Piecemeal, the work would take 10 times as long to do, and would be neither as precise nor as homogeneous.



E. E. Barnard (1857-1923) first made direct photography a powerful means of astronomical discovery. He pioneered in the use of fast wide-field cameras, with which he took long-exposure photographs. He discovered numerous nebulae and clusters, and he called attention to many dark patches, now known to be obscuring matter, in Milky Way star fields.



Photoelectric photometry was revolutionized about a decade ago by the introduction of RCA 1P21 photomultiplier tubes. The photocurrent is amplified more than a million times inside the tube itself. Lick Observatory photograph.

The sad fact is that no observatory plans to do this sort of thing. The large astrophysical observatories all are thinking in terms of large reflectors; they would rather operate with a scalpel than with a sledge hammer. This is as it should be; programs with our few large expensive reflectors must be very carefully considered, and competition for telescope time is vigorous. The point is, however, that both methods of observational attack are necessary, each supplementing and helping the other.

Direct Photography. The two-color survey of the northern sky with the 48-inch Schmidt telescope on Palomar Mountain is the present fundamental contribution being made to observational astronomy by means of direct photography. But we urgently need a second instrument of this kind and size that would extend the Palomar survey to the south celestial pole. There are few exceptions to the fact that in all four categories the southern hemisphere data are less complete than for the northern sky. The southern stars of large proper motion are, thanks to the work of W. J. Luyten, better known than those in the north. The *Henry Draper Catalogue* goes a little deeper in the southern hemisphere.

Direct photography has advanced considerably over the years. For instance, our 36-inch reflector at Goethe Link Observatory, diaphragmed down to 24 inches, gives 20-minute exposures that equal or surpass Curtis' 36-inch Crossley plates of two to four hours exposure, made 50 years ago, mentioned early in this article. This improvement is due to the increased speed of our modern emulsions.

We shall soon want an even deeper look at the universe as a whole than the 48-inch Schmidt can give. It should be possible to build a 96-inch Schmidt, say, which would go at least 1.5 magnitudes fainter—and reach to twice the distance. With plates 14 or 17 inches square, and in a suitable climate, such a telescope could completely photograph a hemisphere of the sky in 10 to 30 years. Two such Schmidts would be needed to cover the entire sky. The question is not whether such observations would be valuable, but rather how one could finance such an ambitious program.

NEWS NOTES

By Dorrit Hoffleit

REAL RADIO STARS?

The few discrete radio sources that have been identified with photographic objects are mainly emission nebulae, like the Crab nebula, or external galaxies. Dr. W. Priester, of Kiel University, suggests that a third of the strong radio sources fall in neither class, but are true radio *stars*, giving off their maximum energy in the long wave lengths of the radio portion of the spectrum.

In the *Zeitschrift fuer Astrophysik*, Dr. Priester estimates that there are 10^{10} to 10^{12} such radio stars in our galaxy, each with an average mass less than 1/10 that of the sun. As none of these objects has been identified with any optically observed star, the radio stars are presumably fainter than visual absolute magnitude 17. Judging from ordinary faint dwarf stars, a radio star would have about 0.14 the sun's diameter and a surface temperature near 2,000° absolute.

While these numerical results are admittedly uncertain, they suggest that the brightest known radio stars must be quite nearby objects.

CHANGE OF DIRECTORS AT LOWELL OBSERVATORY

Dr. V. M. Slipher has retired from the directorship of the Lowell Observatory, Flagstaff, Ariz., and is succeeded by Dr. Albert G. Wilson, who has been assistant director. From 1949 to 1953, Dr. Wilson was in charge of the National Geographic-Palomar Observatory sky survey.

Associated with the observatory since 1901, Dr. Slipher was assistant director when Percival Lowell died in 1916. He has taken an active part in the planetary studies, particularly of Mars, for which the institution was founded. Dr. Slipher's outstanding astronomical contribution was his discovery in 1917 of the apparent recession of external galaxies from the red shifts in their spectra. He also directed the search that led to the discovery of the planet Pluto by Clyde W. Tombaugh. Dr. Slipher plans to continue his research on planets and nebulae.

MASS OF SATURN

The large perturbations that Saturn causes in the motions of other planets makes an accurate knowledge of its mass important in predicting the positions of the planets.

As with any planet-satellite system, there are two methods for estimating the mass of Saturn. In the first, the orbital period and distance from Saturn of one of its satellites are observed; then Kepler's third law gives the planet's mass. The second method amounts to finding from observation the size of the perturbations that Saturn produces in the motion of Jupiter or Uranus; from the amount of these deviations the mass of Saturn can be inferred.

Dr. Hans Hertz, of the U. S. Naval Observatory, has analyzed the observations of Jupiter from 1884 to 1948 to find, by the second method, that Saturn has 1/3497.64 the mass of the sun. Previous determinations of Saturn's mass from its perturbations on Jupiter have been slightly smaller than the values from the satellite method. Dr. Hertz' new result, the most precise yet, effectively removes this discrepancy.

The work has been published under the title, "The Mass of Saturn and the Motion of Jupiter 1884-1948," as Vol. 15, Part II, of the *Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac.*

500 TONS OF METEORITES

Dr. Frederick C. Leonard and Bernard J. Finnegan, of the University of California at Los Angeles, have estimated the total weight of known meteoritic material actually collected and identified as such. It amounts to about 500 metric tons, and represents 1,495 recorded meteorite falls, all those reported to the present time.

The meteorites were classified into three categories: *siderites*, which are composed mostly of iron and nickel; *aerolites* or stony meteorites; and *siderolites*, which contain nickel-iron and silicate materials in roughly equal proportions. As may be expected, the 542 siderites, weighing nearly 428 tons, account for the greatest proportion of the aggregate mass. There are 895 aerolites, weighing over 18 tons, and the siderolites amount to over 21 tons.

HYDROGEN ABSORPTION AT 21 CENTIMETERS

Nearly all investigations of the 21-cm. line of interstellar neutral hydrogen have so far referred to the emission of radio energy. Only within the past year has *absorption* by neutral hydrogen at this wave length been observed, at the Naval Research Laboratory (*Sky and Telescope*, October, 1954, page 412).

Just as in the case of a star's atmosphere, where the cooler gas produces absorption lines in the bright continuous spectrum originating at its surface, so the radio absorption features are seen against some background emission source.

With the NRL 50-foot parabolic antenna, J. P. Hagen, A. E. Lilley, and E. F. McClain recorded three narrow absorption lines due to interstellar hydrogen in the 21-cm. region of the spectrum of the strong Cassiopeia radio source. The intervening hydrogen seems to be collected in discrete clouds or to form dense condensations in a more tenuous medium.

Other sources are now being studied, and 21-cm. absorption has also been detected in Cygnus A and in the Taurus source.

LARGE TELESCOPE FOR JAPAN

Professor Takeo Hatanaka, of the Tokyo Astronomical Observatory, reports that funds for building a 74-inch reflector were voted by the Japanese Diet last March. The telescope has been ordered from Grubb, Parsons and Co. in England and should be completed within about five years. It will have an English-type mounting and be equipped with Hilger spectrographs for both the Cassegrain and coude foci.

The new telescope will not be at Mitaka where Tokyo Observatory is now located. Three 4-inch telescopes are now testing seeing and transparency at proposed sites. One or two years of simultaneous tests will be needed before the final selection.

At present the largest telescope in Japan is the 26-inch Zeiss refractor at the Tokyo Observatory.

IN THE CURRENT JOURNALS

ASTRONOMY IN THE DEVELOPMENT OF PSYCHOLOGY, by Raymond H. Wilson, Jr., *Leaflet* No. 307, Astronomical Society of the Pacific, December, 1954. "The foundations of experimental psychology were laid about a century and a half ago by astronomers discussing the problem of accurate observations of stars' transit times (necessary data for setting clocks and for determining stellar positions)."

THE ORTHODOX THEORY OF THE EXPANDING UNIVERSE, by G. J. Whitrow, *Occasional Notes*, Royal Astronomical Society, No. 17, October, 1954. "On the orthodox theory there is a genuine evolution of the universe as a whole so that the more distant regions are observed by us at an earlier stage of this evolution than are the nearer regions. On the continuous creation hypothesis there is no such *world*-evolution. At present there is no general agreement as to which of these two views is correct."

NUCLEAR MAGNETISM, by Felix Bloch, *American Scientist*, January, 1955. "A new field of research in physics has been opened within the last few years which is now commonly referred to as the study of 'nuclear magnetism'. . . . In contrast to ordinary or 'atomic' magnetism, nuclear magnetism is caused by amperian currents within the nucleus. . . . Unfortunately, there is at present not nearly as much known about the structure of nuclei as there is about that of atoms, and it is indeed one of the chief concerns of contemporary physics to gain more insight of this subject."

LIFE ON OTHER WORLDS

OTTO STRUVE, *Leuschner Observatory, University of California*

WHEN I started working on this article I intended to use the title Astro-Biology. But the time is probably not yet ripe to recognize such a completely new discipline within the framework of astronomy. The basic facts of the origin of life on earth are still vague and uncertain; and our knowledge of the physical conditions on Venus and Mars is insufficient to give us a reliable background for answering the question: Does life exist on these planets, or has it existed in the distant past?

I have therefore adopted the title of a famous book by the Astronomer Royal, Sir Harold Spencer Jones, which has been read by many thousands of people, and has evoked enthusiastic reviews by critics such as Sir James Jeans, who wrote in *Nature:* "It is a model of what such a book should be, popular and scientific at the same time, clear but concise in its writing, with the main theme standing out unburdened by irrelevant details, and the conclusions stated with balance and fairness."

Sir Harold's book was first published in 1940. Since then there has been important new astronomical evidence, such as G. P. Kuiper's studies of the infrared spectra of the planets. There have been even more profound additions to our understanding of the origin of life on earth. And, finally, there has been a revolution in our ideas concerning the uniqueness of the solar system in the galaxy.

My own contribution to these advances is quite small, and pertains only to the last item, the place of the solar system among the stars of our galaxy. I have therefore felt some reluctance about writing on the problems of life on other worlds, but three inspiring articles have helped me to overcome this feeling. The first, in order of time, was Kuiper's revision of the chapter on "Planetary Atmospheres and Their Origin" in the 1952 edition of *The Atmospheres of the Earth and Planets* (University of Chicago Press). The second was George Wald's summarizing article, "The Origin of Life," in the August, 1954, issue of *Scientific American.* The third was a comprehensive discussion by V. G. Fessenkov entitled, "On the Physical Conditions and the Possibility of Life on Mars," in the Russian periodical, *Problems of Philosophy,* No. 3, 1954. We have here authoritative opinions by two astronomers and one biologist who have contributed to our problem. The writings of an equally distinguished chemist, Harold Urey, with whom I have also had a number of discussions, have still further influenced my own ideas.

We take the view that life is an intrinsic and inseparable property of certain aggregates of very complex organic molecules. No such aggregates have been produced artificially, but if we could make them in the laboratory, we would undoubtedly find them to be "alive."

We shall also adopt the opinion of many modern biologists and speak of a "spontaneous generation" of living molecules and their aggregates by natural processes—the formation of highly complex organic molecules in a medium containing the required kinds of atoms.

The principal building blocks of living organisms are the carbohydrates, fats, proteins, and nucleic acids. All of them are complicated structures containing dozens or hundreds of atoms. They consist almost entirely of the rather common atoms, hydrogen, carbon, oxygen, and nitrogen. All these atoms are abundant on the earth, and presumably also on other planets. The unusual feature of these molecules is that so many simple atoms are bound together in a single entity. How have they ever succeeded in being at the same place, at the same time, to combine into a single molecule?

Let us consider briefly how a simple inorganic molecule such as water, H_2O, is formed. Each atom of H has a single electron that revolves around a proton. The O atom has eight electrons, two in an inner shell and six in an outer shell. But the inner shell can never contain more than two electrons. Helium, which actually has two electrons, has its innermost shell filled to capacity and it has no further room to accommodate additional electrons. Hence, the atom of He is inert; it does not easily combine with other atoms and rarely appears as a partner in a molecule.

The second shell of electrons, as the physicists tell us, may contain as many as eight electrons. Neon atoms have a total of 10 electrons, two in the inner shell and eight in the outer. There is no more room for additional electrons in the outer shell; thus neon is also inert, and we call it a *noble* gas.

But oxygen has two empty spaces in its outer electronic shell. Hence it is chemically active. It can attract free hydrogen atoms and place the two electrons, one from each H atom, in these vacant spaces. This binds the atoms into a molecule containing a total of 10 electrons.

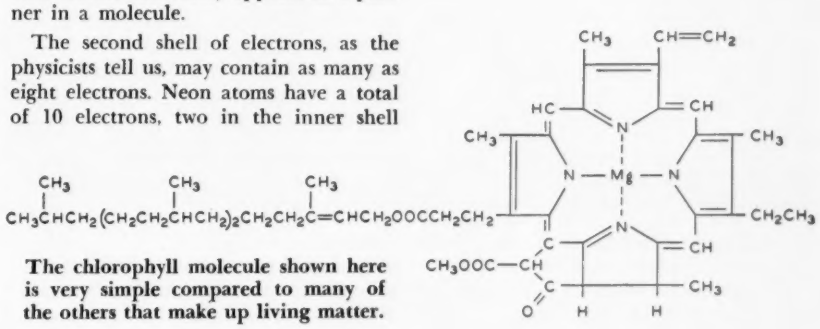
Whatever the binding forces are, the atoms must somehow get close enough together—not necessarily at one time, for conceivably an OH molecule might be formed first, which could later become H_2O.

It would seem, at first sight, that the probability of forming the complex organic molecules as the result of chance encounters between hundreds of atoms is so small as to be ruled out. And spontaneous formation of an advanced living organism is too improbable to have even once taken place during the five-billion-year history of the earth, or even on any of the millions or billions of planets that probably exist in our Milky Way galaxy!

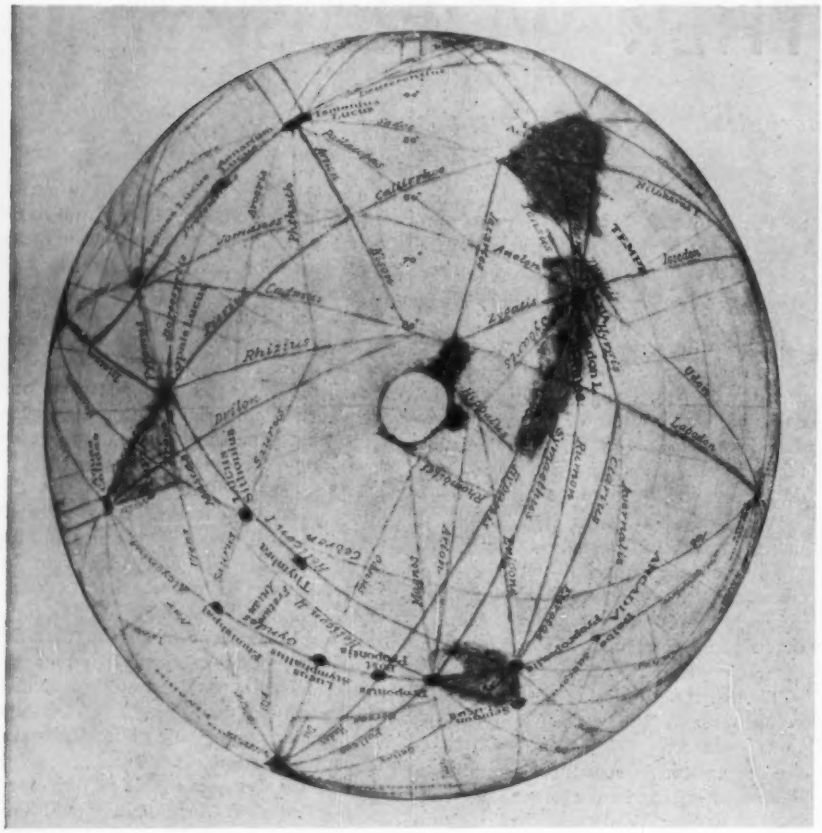
But the complex organic molecules raise less difficulty. However, the atoms must have a chance to approach one another, not once, but billions of times within a short interval.

In a solid substance, the atoms are prevented from doing this. We need a liquid or gaseous medium to satisfy this condition, say, water or air for terrestrial life.

About two decades ago, A. I. Oparin suggested that given enough time, organic molecules might form spontaneously in a gas containing water vapor, methane (CH_4), ammonia (NH_3), and hydrogen. Inspired by this idea, one of Urey's students, S. L. Miller, at the University of Chicago carried out an experiment with these gases, continuously circulating them



The chlorophyll molecule shown here is very simple compared to many of the others that make up living matter.



A Percival Lowell map of the northern hemisphere of Mars, with the north polar cap in the center, from his observations of 1901. Lowell maintained that the canals formed a geometrical network and were artificial watercourses. This view is no longer held, and later observers seldom describe the canals as narrow rulings forming so regular a pattern as this.

through a glass tube where they passed into a strong electrical discharge. At the end of a week there appeared in the mixture certain organic molecules, such as glycine and alanine, which form parts of the more complex protein molecules.

Even though the probability of the spontaneous formation of a molecule is exceedingly small, the number of atoms in water is exceedingly large, and the time interval during which some such process may have operated in nature is exceedingly long. Most biologists believe that the origin of life on earth occurred in large, warm (but not hot) bodies of water, rather than in air. If spontaneous generation had first operated in air, the primitive organisms would probably have been destroyed rapidly by the ultraviolet light of the sun.

It is thus reasonable to believe that living molecules or aggregates of molecules were formed by encounters in water. Do they have a chance to multiply, to expend energy upon the process of "living," and to combine gradually to form more complicated living beings?

Presumably there was no free oxygen in the water, or in the earth's atmosphere, before there was a vast population of primitive living organisms. Since oxygen is exceedingly active chemically, any small amount of it that might be released in volcanic eruptions, or be produced by sunlight from the decomposition of water and other oxygen-containing molecules, would be used up immediately to oxidize the solid rocks of the earth's surface. Some rocks are even now underoxidized: they seek to take up any available free oxygen and bind it up in more highly oxidized solid or liquid compounds.

Perhaps there was not even any carbon dioxide in the original nitrogen-heavy atmosphere of the earth—though on this point there is less unanimity.

It would appear that the original watery home of the primitive living molecules contained nothing that could be used for food. The molecules were compelled to feed upon each other, a rather destructive process which, unless promptly arrested, would destroy life as rapidly as it was created by spontaneous generation.

It has been suggested, however, that the process of feeding of some organic substances upon others is like the fermentation of sugar by yeast. This produces a small amount of energy, enough to satisfy the very limited living requirements of primitive organisms, and produces alcohol and carbon dioxide. Hence, even if CO_2 was not at first available it might have been produced by the organisms themselves.

Once CO_2 became available, the remaining organisms could tap a new and exceedingly rich source of energy, sunlight, without having to rely upon the wasteful process of fermentation. Sunlight enables the CO_2 to combine with H_2O, giving sugar and free oxygen. We call this process photosynthesis.

Thus all that was needed was the formation of some CO_2. Photosynthesis would then automatically produce more sugar that could again be fermented. But it would also produce free O_2, not previously available, and this paved the way for a new source of the vital need of all organisms—energy. The free oxygen would oxidize the sugar and other organic molecules, replenishing the supply of CO_2, and making more energy available.

The foregoing picture biologists have painted for us agrees reasonably well with the astronomical evidence. The original atmosphere of the earth contained no O_2 and little or no CO_2. The atmosphere and the surface of the earth, including the oceans and extending a short distance below the solid surface, constitute the *biosphere,* a layer whose present chemical composition has been greatly influenced by the presence of living organisms, chiefly the plankton of the oceans. Our present supply of free O_2, nearly one fifth of air, is almost entirely the result of photosynthesis. If all life were suddenly extinguished, the free O_2 would disappear in about 2,000 years. Similarly, it is possible that there was no original CO_2, and that all the available carbon was present in the form of the pure element, in hydrocarbons such as methane, or in metal carbides.

There is, however, no absolute certainty that *all* atmospheric O_2 was produced by living matter. Several geophysicists believe that some O_2 was freed by the photochemical decomposition of water in the atmosphere. It is more probable that a large percentage of the available CO_2 has been produced by volcanic eruptions and by chemical reactions, in the presence of water, among solid substances in the crust of the earth.

Most of air is nitrogen, N_2. This molecule is so heavy that the earth can now prevent it from escaping into space. But the gas neon, which is almost as heavy, is present only in minute quantities. Undoubtedly, at some time in the distant past, the temperature of the earth was much higher than now. Since the velocities of the molecules are larger at high

temperatures, we believe that most of the neon then escaped, and with it the nitrogen and water vapor. Thus the N_2 and H_2O in the atmosphere today must be of "secondary" origin. N_2 escapes from volcanoes and fumaroles, and water vapor may have been produced from the breakdown of hydrated silicates in the earth's crust—containing "fossilized" water.

But N_2 is also exhaled by certain abundant bacteria. For this reason V. I. Vernadsky has suggested that the present N_2 gas in our atmosphere is partly biogenical and partly tectonic in origin.

Let us now turn to the problem of life on Mars. The observations show that its atmosphere contains no free O_2, certainly less than 0.1 per cent of its abundance in air. Water vapor has not been found, but its existence is inferred from Kuiper's demonstration that the polar caps consist of hoar frost. The abundance of H_2O in the Martian atmosphere is less than 1/1,000 of what we find in air. There is a considerable amount of CO_2, several times as much as in air. The total amount of atmosphere on Mars above every square centimeter is about 1/10 the air above the earth. About 98 per cent of it must be N_2, which is unobservable in the accessible region of the spectrum. Argon and CO_2 together constitute almost two per cent, the former presumably being of radioactive origin on Mars as on the earth. Other gases constitute less than 0.5 per cent.

There are no permanent free water basins on Mars. Any moisture that may result from the melting of the polar caps is of a seasonal character.

The temperature on Mars averages 30 to 40 degrees centigrade lower than on the earth. On the Martian equator, the mean temperature is −10° or −20° C., with the noontime maximum at about +20° C. Near the poles the average temperature is about −60° C. Fessenkov believes that Martian conditions are similar to what we might expect on a hypothetical terrestrial plateau 10 miles high.

It is clear that with the absence of water there does not now exist a biosphere on Mars. No life can originate there at the present time. The absence of free O_2 confirms this. The abundance of N_2 and CO_2 indicates that they are not of biogenic origin.

But perhaps conditions on Mars were different in the distant past. Did life come into being when there was more water? Fessenkov, while admitting we cannot answer this question, argues that the green regions on Mars are not caused by vegetation, even the primitive kind of lichens and mosses considered by Kuiper. He refers to the absence of the spectral features of chlorophyll in the reflected sunlight, which rules out all more advanced types of vegetation. He also remarks that the observed temperatures of the green regions are about 15 degrees warmer than those of the adjoining yellow deserts. Both kinds of regions receive the same amount of solar radiation per square centimeter, Q. But the reflectivity (or albedo) of the yellow regions is about 0.30, and of the green regions only 0.15. Hence the yellow regions use only $Q(1 - 0.30)$ of solar radiation for heating the surface, while for the green regions the amount is $Q(1 - 0.15)$. By Stefan's law the temperature of a heated area is proportional to the fourth root of the amount of radiation used for heating. This gives the relation:

$T^4_{green} = T^4_{yellow} \ (1-0.30)^{1/4} / (1-0.15)^{1/4}$.

The result is $T_{green} - T_{yellow} = +15°$. This is exactly in accordance with the observations. But living organisms use energy to maintain growth and reproduction: Areas covered with vegetation are always cooler than similar areas devoid of plant life. Fessenkov concludes that the green areas reflect sunlight as would a dark surface of inorganic matter—perhaps some green-colored rock or shale of a kind that may be found in many of our own deserts.

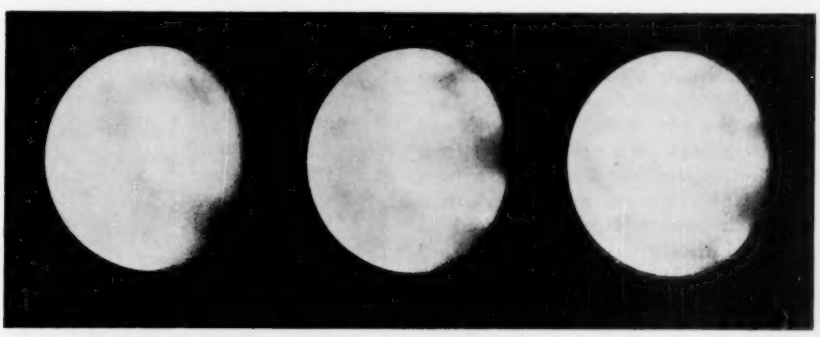
The argument is sound and interesting, but it does not exclude the existence of a sparse distribution of lichens or mosses, covering only a fraction of the entire area and yet giving it a greenish tinge. The cooling produced by such primitive plants might be negligible. Perhaps the intervening surface consists of a kind of inorganic substance that is intrinsically darker than that of the yellow regions, and is for this very reason better suited to support the existence of the lichens or mosses.

Nevertheless, the present conditions on Mars are so unfavorable to the origin of any living organisms, that any lichens or mosses which may now grow in the green areas would cause us to believe that there once was more liquid water on the surface of Mars.

In many respects, the planet Venus is even more interesting than Mars. In mass and size it resembles the earth. The escape velocity of the molecules (10 kilometers per second) is nearly the same as for the earth (11 kilometers per second), instead of five kilometers per second as for Mars. The amount of solar radiation is greater, and the surface temperature may be considerably higher than that of the earth. Perhaps it is so hot, above the boiling point of water, that there could be no oceans. But this is unlikely: at least the polar regions of Venus may be below 100° C.

We never see the surface of Venus. It is permanently covered with clouds of unidentified composition. The atmosphere of Venus resembles that of the earth in total amount and in its density distribution. But there is no observed free O_2 or water vapor. Instead, an amazing amount of CO_2 has been revealed by the spectroscope.

Until quite recently, astronomers concluded that the invisible surface of Venus is completely devoid of water and is a dry, dusty desert with no life of any kind. The absence of free O_2 seems to support this view; and the presence of CO_2 and probably also N_2 need not disturb us, since we have already concluded that on Mars these gases are probably not of biogenic origin. If these views are correct, we conclude that life has never existed on Venus in the past—its temperature would never have been lower than at present, and it is improbable that there could have been any water in the liquid state. There remains the rather vague possibility—supported by little more than wishful thinking—that life may come into existence on Venus in the future. It is conceivable that its atmosphere might clear up and gradually reduce the influence of the greenhouse effect of the CO_2 and dust in its atmosphere. If the surface temperature should drop well below 100° C., water might appear from tectonic causes and organisms could then be produced by spontaneous generation. Spencer Jones, in his book referred to previously, said: "Venus appears . . . to be a world where life may be on the verge of coming into existence and Mars a



The brilliant cloud-covered disk of Venus visually shows little beyond slight shadings such as those pictured here by L. Rudaux. Day-to-day changes indicate they are atmospheric phenomena. From "Astronomie," by Rudaux and de Vaucouleurs.

world where life is in the sere and yellow leaf."

There can be no question that the absence of water vapor in the atmosphere of Venus is our greatest difficulty. Because of the great similarity of the earth and Venus, we should have expected that H_2O would be abundant. It is therefore necessary to re-examine the evidence. We are certain that there is no observable H_2O above the cloud layer of Venus. But perhaps it could be present below the clouds, on the surface, and even in the clouds themselves. This question has been treated by D. H. Menzel and F. L. Whipple (see *Sky and Telescope*, November, 1954, page 20). They suggest that the surface of Venus is *completely* covered with water. No continents stick out above the level of the ocean. This prevents the destruction of atmospheric CO_2 through the formation of carbonates in the rocks (a process that we have already considered as maintaining the equilibrium content of CO_2 in the atmosphere of the earth). The temperature *above* the clouds of Venus is −39° C., according to W. Sinton. At this temperature most water vapor would be frozen out, and it is not surprising that we do not observe it spectroscopically.

The ideas advanced by Menzel and Whipple are so revolutionary that it is difficult to appraise them at this time. But if confirmed they would certainly justify the confidence of Spencer Jones that Venus is a planet of life in the beginning. The fact that there is no O_2 would indicate that there has not yet appeared any large amount of vegetation.

I want to refer, in conclusion, to the problem of life elsewhere in the galaxy. Spencer Jones reached the pessimistic conclusion that "such a special combination of circumstances is needed to account for the solar system that it can be inferred that relatively few stars have

(Continued on page 146)

ASTRONOMICAL SCRAPBOOK

Schroeter's Observations of Mars

A HUNDRED and fifty years ago the world center of lunar and planetary studies was the little North German town of Lilienthal, near Bremen. Here were the observatory and optical shops of J. H. Schroeter (1745-1816), chief magistrate of the neighborhood, who for nearly 30 years kept unflagging watch upon the moon and planets. Here his assistant, K. L. Harding, discovered the third asteroid, Juno, and the famous F. W. Bessel began his career.

Fate was unkind both to Schroeter and to his reputation. The decades of war that convulsed Europe finally engulfed him in April, 1813, as Napoleon sought to regain his slipping hold on Germany. Lilienthal was sacked and burned by the French army of General Vandamme, and Schroeter lost at one stroke his observatory, records, magistrateship, and wealth. Unable to resume observing, he died three years later.

This enthusiastic amateur, the Percival Lowell of his age, has been underrated by later astronomers. His own work overlapped that of his more versatile, brilliant contemporary, William Herschel, whose fame has obscured all other observers of his time. Again, it has been Schroeter's misfortune to be remembered more for his faulty rotation periods of Mercury and Venus than for being the first astronomer to devote a lifetime to telescopic study of the planets. And, finally, the row of fat volumes devoted to his findings on Mercury, Venus, Jupiter, Saturn, and the moon, was written in a fantastically unreadable style that left their contents largely unnoticed.

The Lilienthal astronomer published no book on Mars, although he had followed this planet intensively. It was long supposed that his manuscript of Martian observations had been destroyed in the ruin of his observatory. Finally recovered among the family papers of a nephew, the Mars writings were published in 1881 by the Dutch astronomer, H. G. van de S. Bakhuyzen, together with 216 of Schroeter's drawings.

A curious delusion pervades this book—that the Martian markings were mere wind-blown cloud formations in a thick atmosphere that veiled the true surface of the planet. Acting on this belief, Schroeter from night to night carefully estimated the times when various dark markings crossed the central meridian of the planet, in an effort to measure Martian wind velocities. These markings can often be identified; hence Schroeter's transit times might be used in combination with recent observations to determine the rotation period of Mars with high precision.

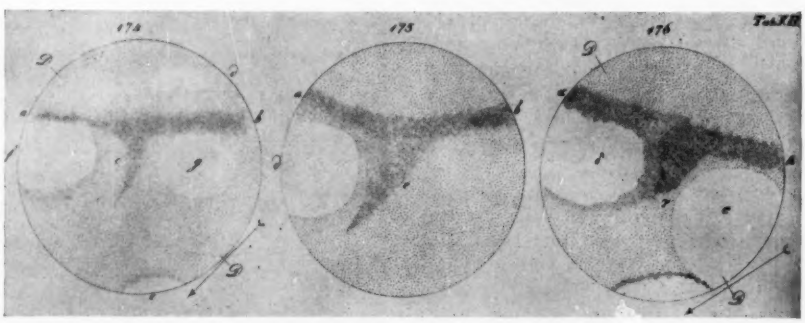
No one has ever done this, and in fact this valuable material seems to have been totally overlooked. Heretofore, in studying Martian rotation, only Schroeter's drawings have been used, and they are ill-suited for the purpose.

The drawings are, nevertheless, of much value in looking for surface changes on Mars, for they were made with instruments respectable even by modern standards. Schroeter's first large telescope was a reflector of 7-foot focus, made by William Herschel; and in 1792 he acquired a 9.3-inch, f/17 Schrader reflector which Lalande called the finest telescope in existence.

While most of the features in these drawings are identifiable on present-day maps, there is a very striking exception. This is a dark region nearly as large as Texas, marked on 16 of Schroeter's sketches of 1798-1800, which is no longer to be found. Two drawings made by Herschel in 1783 also show it. Bakhuyzen, who wrote in German, named it *Spitze B;* we might call it the *Arrowhead.*

Both Schroeter and Herschel represent this as a long triangular marking much like Syrtis Major. Its location can be found on the Mars map on pages 268-269 of the August, 1954, issue. The base of the Arrowhead was near longitude 225°, latitude −15°, at the edge of Mare Cimmerium; it stretched northward over the canal Cyclops and Pambotis Lacus. These last two may be its remnants.

The disappearance of this vast tract—for two decades one of the most easily seen features on Mars — is the most striking change yet recorded on the surface of the red planet. Its explanation is an intriguing puzzle. J. A.



Three Schroeter drawings of Mars, made with a 9.3-inch reflector during the favorable opposition of 1800. Left to right: On November 2nd, the Arrowhead was near the center of the disk, extending downward toward the north polar cap; 3½ hours later that night, the Arrowhead had rotated leftward out of view, and Syrtis Major was centrally located; on November 4th, the Arrowhead was again central. From Schroeter's "Areographische Beitraege," Leiden, 1881.

Amateur Astronomers

WESTERN CONVENTION PLANS

Yosemite National Park in California will be the scene of the seventh annual convention of Western Amateur Astronomers on August 19-21. Every effort is being made this year to interest more of the general public in astronomy, and the thousands of visitors in Yosemite will be welcome in addition to the members of the 14 societies that comprise the WAA. Hosts are the Sacramento, Stockton, and Fresno groups, with Carl W. Anderson as convention chairman.

The program chairman is Arthur Leonard, 815 Douglass Ave., Davis, Calif. Those intending to present papers should notify Mr. Leonard.

Extensive exhibits are planned, under the charge of the undersigned, with whom manufacturers and distributors of astronomical equipment should communicate. Latest materials and devices used by astronomers in their work will be shown.

VICTOR W. KILLICK
1857 Fourth Ave.
Sacramento 18, Calif.

MIAMI PUBLIC OBSERVING

Two observing stations operated by amateurs belonging to the Southern Cross Astronomical Society are open each week the year around in the Miami area. Each is equipped with a 5-inch Clark refractor. They afford visiting astronomy enthusiasts with limited time a better chance to enjoy their hobby than do our once-a-month meetings.

The observing at the Miami Shores Library is on Thursday evenings from 7:30, and at the Miami Beach Library, on Friday evenings from 7:30.

ARTHUR P. SMITH, JR., secretary
426 S. W. 26th Rd.
Miami 45, Fla.

NEWBURGH, NEW YORK, AND AMATEUR "RADIO ASTRONOMY"

The Newburgh Amateur Astronomical Association meets at the Naval Reserve Training Center on the first and third Wednesdays of each month. We now have nine members. Observing equipment includes a 6-inch reflector, two Skyscopes, cameras and accessories, and instruments of my own, a 6-inch, a 3-inch refractor, and Bausch and Lomb camera.

Here is an anecdote relevant to the article by Harry de Meyer, of Belgium, that appeared in the December Gleanings for ATM's. Early in December, John H. Smith, a "ham" radio operator, W2BCR in Newburgh, called to tell me that a friend in Belgium needed a list of astronomical literature. I told him about the article, and he passed the author's address on to his friend, Jo F. Duchene, ON4DX, in Gand, Belgium. Mr. Duchene went to visit Mr. de Meyer in Sint-Kruis-Bruges and was treated royally, although Mr. de Meyer was surprised to see him, as his copy of **Sky and Telescope** had not arrived in Europe as yet.

JOHN SANFORD
8 Farrington St.
Newburgh, N. Y.

ALBANY, NEW YORK

Over a year ago, some interested amateurs formed the Albany Astronomical Association. The group now includes 10 high school boys, but it is our hope that adults interested in astronomy will join us so we may have a more permanent organization.

Now in use are two 6-inch and three 3-inch reflectors, as well as several small refractors. Plans are under way for the construction of a reflector of 10 or 12 inches aperture.

Meetings are held every two weeks at members' houses, and arrangements for a permanent meeting place are presently under consideration.

ERIC LIFSHIN, president
252 Lenox Ave.
Albany, N. Y.

ROANOKE SOCIETY FORMED

A meeting of amateur astronomers in Roanoke, Va., on November 19th, resulted in the formation of a new group, the Amateur Astronomers of Roanoke. Twenty-five persons attended, with ages ranging from 12 to 62. The group ultimately anticipates a membership of over 100 from the Roanoke area.

Meetings will be held at the YMCA on the second Friday of each month. Officers elected were Harry E. Wickes, president; Herbert R. Klink, vice-president; Robert L. Little, treasurer; and Mrs. Katherine Burke, secretary.

Anyone interested in joining the new society should contact Mrs. Burke at 11 Mountain Ave. S.E., or phone 3-2359.

HARRY E. WICKES
17 Sunset Village
Roanoke, Va.

RICHMOND JUNIORS ORGANIZED

The Richmond Astronomical Society has developed a junior program, with three or four adults sponsoring neighborhood groups throughout the city.

I am counselor for the north side of the city and have two small groups meeting once or twice a month. My largest group is in the 10-to-11 age bracket, with from 15 to 20 members. The smaller section is for ages 12 through 15; juniors of these ages get more done, but have many other interests.

J. S. STITH
3125 Lamb Ave.
Richmond 22, Va.

THIS MONTH'S MEETINGS

Brooklyn, N. Y.: Brooklyn Institute of Arts and Sciences, 8:15 p.m., Academy of Music. Feb. 25, Dr. W. F. G. Swann, Bartol Research Foundation, "Recent Findings on Cosmic Rays."

Cambridge, Mass.: Bond Astronomical Club, 8 p.m., Harvard Observatory. Feb. 3, C. A. Federer, Jr., Harvard Observatory, "Astronomy Out West."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Feb. 11, Dr. Aden B. Meinel, Yerkes Observatory, "New Horizons in Astronomical Instruments."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Feb. 8, Dale Bufkin and others, "Grinding, Testing and Silvering of Telescope Mirrors."

Minneapolis, Minn.: Minneapolis Astronomy Club, 7:30 p.m., Science Museum. Feb. 2, Wensell S. Frantzich, "The Solar System."

Montreal, P. Q.: Royal Astronomical Society of Canada, 8:15 p.m., McGill University. Feb. 7, K. Brian Cockhill, "The Moon."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Feb. 2, Dr. Peter van de Kamp, Sproul Observatory, "Evolution in Binary Stars."

Oakland, Calif.: Eastbay Astronomical Society, 8 p. m., Chabot Observatory. Feb. 5, brief presentations by various members.

Rutherford, N. J.: Rutherford Astronomical Society, 8:15 p.m., YMCA. Feb. 3, Mrs. A. Cox, "Biography of Famous Astronomers"; Fred Waite, "Astro Engineering."

South Bend, Ind.: St. Joseph Valley Astronomers, 7:30 p.m., YMCA. Feb. 3, Richard Foltz, "Clock Drives."

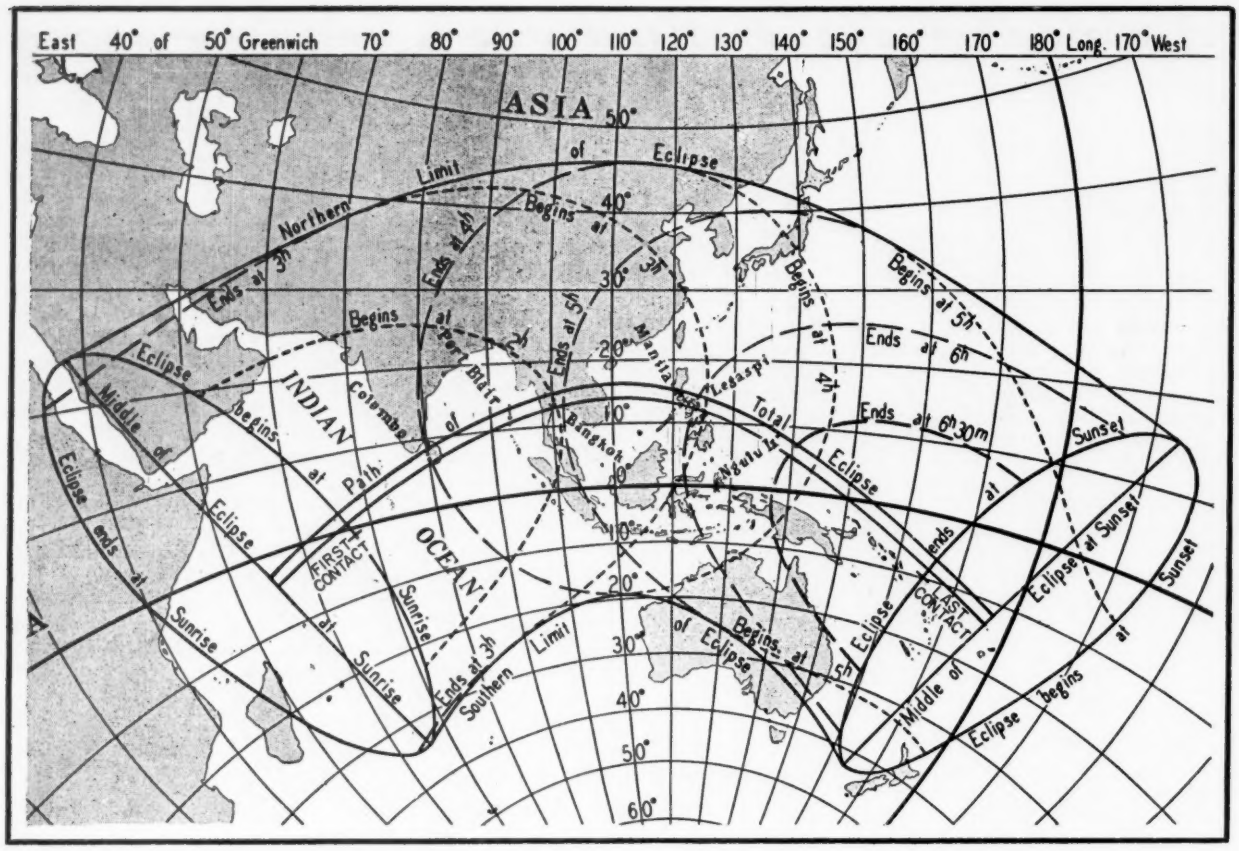
THE POLE OF ROTATION OF VENUS

(Continued from page 131)

pole of Venus (that point in the sky toward which its axis is pointing) at right ascension $3^h\ 32^m$, declination $+81°$, in the constellation of Cepheus. The pole of Venus' orbit is at $18^h\ 24^m$, $+66°$; thus, its equator is tilted about 32 degrees from its orbit plane, the uncertainty being perhaps two degrees, according to Dr. Kuiper.

The rotation period of Venus is still unknown, and Dr. Kuiper expects to make further observations to determine the speed of rotation. From the stability of the bands, he believes that the rotation of Venus may require a few weeks at most.

This estimate agrees with Mount Wilson spectroscopic work, which showed that the rotation must require more than one day, and with the small temperature difference between the sunlit and dark halves, which rules out a period much longer than a month.



On June 20th, the sun will be partially obscured for observers from Arabia to New Zealand, and will be totally eclipsed along a narrow strip running through Ceylon and the Philippine Islands. In this map, reproduced from the "American Ephemeris and Nautical Almanac," Universal time is used.

THE LONG ECLIPSE — June 20, 1955

THE TOTAL ECLIPSE of the sun on June 20, 1955, will be remarkable for the very long maximum duration of totality, seven minutes 7.8 seconds. This is unmatched by any other eclipse in the past 1,250 years, and will not be exceeded until July 6, 2168.

This longest duration will be reached when the moon's shadow crosses the China Sea. The most accessible part of the shadow path for American observers is the Philippine Islands, where totality occurs near local noon, and averages seven minutes long.

Another important region crossed by the moon's shadow is the island of Ceylon, off the southern tip of the Indian peninsula. Totality will occur there at about 8 a.m. local time, and have a duration of only 4.2 minutes at Colombo.

At Manila, the first encroachment of the moon upon the sun's disk will be at 10:47:12 Philippine standard time (meridian 120° east). Totality lasts from 12:18:58 to 12:25:11, and the end of the eclipse comes at 13:52:26. At mid-eclipse the sun's altitude will be 79° 24′.

Planning for observations in the Philippines must include consideration of weather, as June is in the rainy season, and careful site selection is necessary to maximize the chances of successful observation. Much useful information is contained in the pamphlet on astronomical and meteorological conditions for the eclipse prepared by the Philippine Weather Bureau, under the direction of Casimiro del Rosario. This publication gives detailed data concerning 10 sites, all of which are shown on the accompanying map, including notes on living conditions and accessibility for each.

The weather factors are temperature, humidity, cloudiness, and rain, of which the last two are more important. In June, everywhere in this part of the Philippines the temperature is high, day and night, with the average about 82° Fahrenheit. For the 10 stations, the average maximum is about 90°, and the average minimum is about 76°. Nevertheless, 99.8° was the highest recorded in the five years, 1949-1953, at Ambulong, with Manila's highest in that time 95.6°. The relative humidity is also always high in June, averaging over 80%.

Daytime cloudiness has been studied with a specific view toward the chances for seeing the sun at 11 a.m., about one hour before the onset of totality. More details will be given in the synopses for the stations.

Although the average number of days with rainfall measuring 0.01 inch or more is 17½ for the 10 stations, the average number with rainfall between 10 a.m. and 1 p.m. is only 6.3. Manila averaged 12.72 inches June rainfall for the five-year period, but Ambulong only 5.84 inches; Lucena, 5.26; Legaspi, 8.26; and Daet, 5.75. Iba, on the open coast, facing the southeast monsoon, averaged 25.31

inches of rain in June; measurable rain fell there on 22 days, yet only five days between 10 a.m. and 1 p.m., on the average.

For the period June 10-30, 1954, the Philippine meteorologists took special weather records at all 10 stations. They observed the visibility of the uneclipsed sun for each hour of the day from 8 a.m. to 4 p.m., using overexposed photographic film as a filter. They drew up a table showing the percentage of days when the sun was clearly visible, when it was seen through clouds, and when it could not be seen, obscured by clouds or rain.

It is seen that of the 10 stations Iba is at the edge of the path, while Infanta and Masbate are nearer the edge than the center. Virac is difficult of access, except by an airplane. There are six sites covered by the bulletin that merit consideration, and for which brief synopses will be given here. Serious observers should obtain the bulletin directly from the Philippine Weather Bureau, Manila. P. I., for complete information.

Manila-WBFC: Though not on the central line, Manila is attractive for its facilities and the relative ease with which it can be reached. There the duration of totality will be six minutes 13 seconds, and at mid-eclipse the sun's altitude will be 79° 24′. Not far away, at Paranaque, Rizal, is situated the Weather Bureau Forecasting Center (WBFC) at Nichols Field. This would obviously be a good station from which to plan airplane flights.

On the average of 21 June days in 1954, the Manila area had a sky cloud coverage of about 7/10. Low, middle, and high clouds covered 4/10, 2/10, and 1/10 of the sky respectively, at noon at Manila. At WBFC, these noon figures were 3/10, 2/10, and 3/10. Over the preceding five years, the average low and middle cloud cover was 5/10 and 6/10 at Manila and WBFC, respectively, at 11 a.m. The chances for successful ground observations in this area are estimated at between 30 and 40 per cent. In June, 1954, however, the sun was clearly visible without any type of cloud covering it 62% of the days at 11 a.m. at Manila; 52% at noon, and 62% at 1 p.m. At WBFC, these figures were 62%, 62%, and 47%.

Ambulong: This is a rural community, in Batangas province, hilly and covered with luxuriant vegetation. It may be reached by a two-hour automobile ride from Manila, but accommodations are not good. It is more favorable than the Manila area from the standpoint of total rainfall, but low-level cloudiness is on the average greater at 11 a.m.

Lucena: This is the capital city of Quezon province, and is located close to the central line. Totality will last for seven minutes two seconds. At the head of Tayabas Bay, Lucena is two hours by road from Manila, and has rail and air connections. Good living conditions and the local availability of photographic and electronic supplies make this a suitable base for eclipse observers.

The average total cloudiness during June is 8/10, as at Manila, but the chances of visual observations from the ground at eclipse time seem poorer, only about 23 per cent. But in June, 1954, the sun was clearly visible from Lucena 62% of the time, and it was visible through clouds 28% of the time. On only two days (10%) was it completely obscured at 11 a.m., noon, and 1 p.m.; these figures for Manila are 19%, 19%, and 14%, and for WBFC 24%, 24%, and 14%.

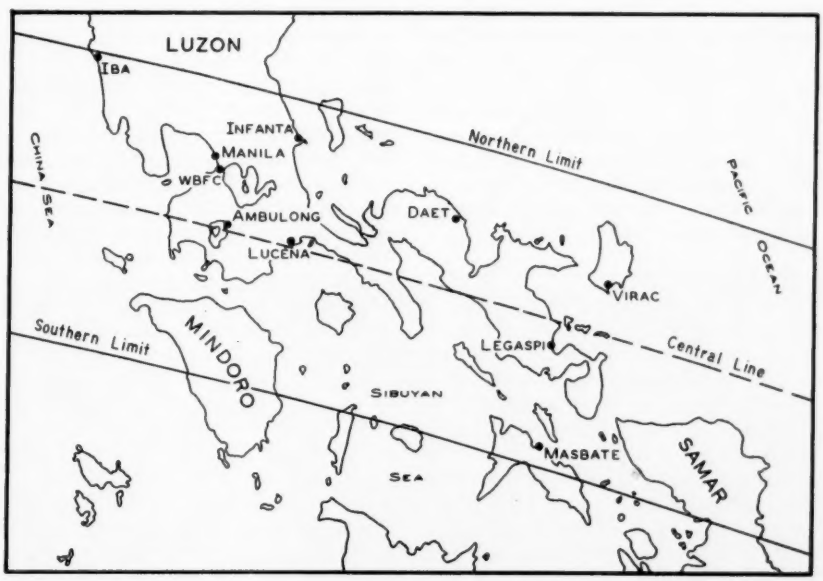
Legaspi: This large city is near Mayon volcano. The weather bureau station is located on a flat-topped hill about 300 feet high that overlooks the entire city. Like Lucena, it is easy of access, by rail, road, water, and air, and it has all needed facilities. In cloudiness, however, it is practically the least favorable of all 10 sites. At 11 a.m., it averages 7/10 low and middle clouds, with a total of 9/10 cloud cover. Chances of ground observations succeeding are only about 18 per cent, although in 1953 this was 32 per cent.

Daet: This is the capital of Camarines Norte. It is situated not far from two mountains, each some 2,500 feet high or more. It is accessible by rail, bus, and air. There are three hotels and two lodging houses, several camera shops and electronic supply houses.

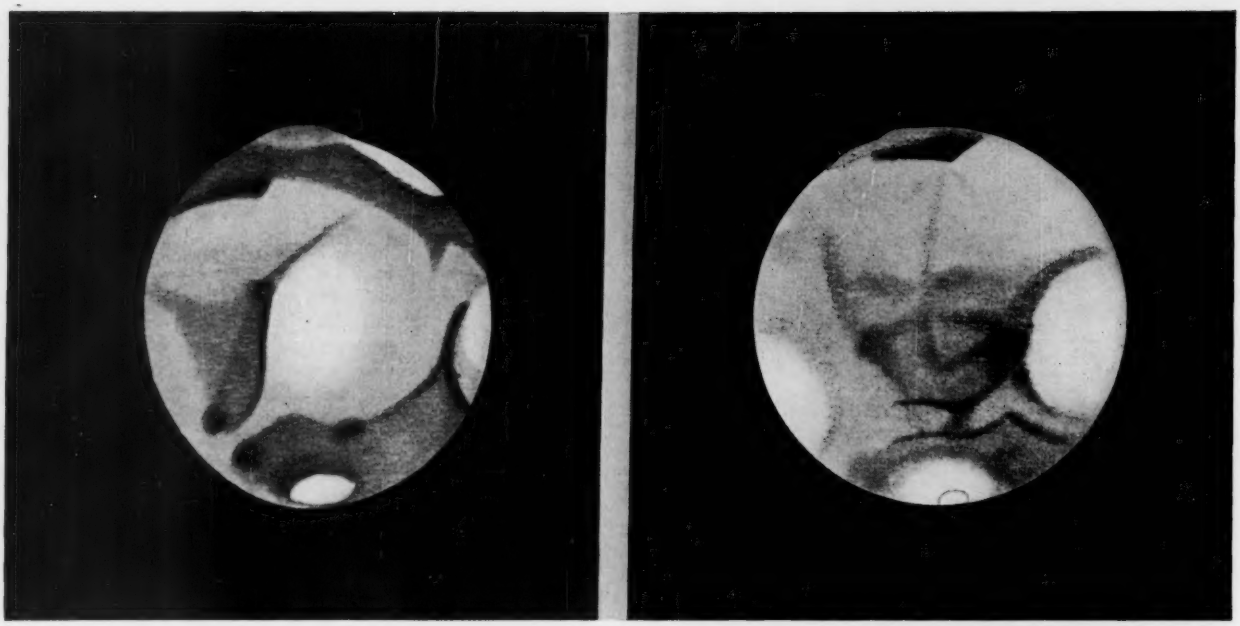
The geographical position of this city differs from most of the other 10 stations in that it is on the north and east coast, where monsoon winds reach it only after passing over several large islands and mountain regions. Director del Rosario rates it very high compared with all the other stations, setting the probability of successful ground observations at 54 per cent. However, Daet's midday cloudiness and rain appear less favorable than some other stations'. At this place, totality will last six minutes and seven seconds.

Mr. Hans Arber, of Manila, suggests the suitability of Tagaytay City, about 50 miles from Manila and very close to the central line. Since the Manila Hotel maintains a resort lodge there, almost 2,000 feet above sea level, the location is attractive from several standpoints. Nothing is stated, however, concerning the advantages or disadvantages of a mountain location in the Philippine climate. Mr. Arber offers to assist any observer making genuine inquiries. He may be reached at P. O. Box 125, Manila, P. I.

The probability of low and middle cloudiness is greater than that of high clouds at most stations. Therefore, the best observations may be made from airplanes, but several factors should be considered in planning a flight. The plane should be pressurized, to permit attaining altitudes as high as 20,000 feet and more. Inasmuch as the sun will be only 11 or 12 degrees from the zenith, the plane must fly in a banked position to permit observation through conventional windows. During such a long eclipse, several changes in course will be possible to give all passengers an equal opportunity to view the corona.



The path of totality across the central Philippine Islands on June 20th is shown here, in an adaptation of a map prepared by the Manila Weather Bureau. The 10 sites at which detailed weather studies were made are marked.



Two drawings of gray clouds projecting over the southern (upper) edge of Mars. Tsuneo Saheki's drawing at the left was made January 15, 1950, at 19:30 Universal time, with 400 power on an 8-inch reflector. Mars was then 8.7 seconds in apparent diameter; Martian longitude 202° passed through the center of the disk. S. Ebisawa's drawing, right, was made on March 29, 1950, at 11:55 UT, when the central meridian longitude was 160°. He used powers of 160 and 240 on a 6-inch.

MARTIAN PHENOMENA

Suggesting Volcanic Activity

TSUNEO SAHEKI, *Osaka Planetarium*

ARE THERE volcanoes on Mars? If so, are any active now? These are difficult questions, for we know very little about the inner structure of that planet. Yet visual observers of Mars frequently see what may be volcanic clouds. Recently, D. B. McLaughlin, of the University of Michigan, suggested that the dark features of Mars may be wind-blown drifts of ash coming from Martian volcanoes. Earlier, B. Lyot and A. Dollfus, at the Pic du Midi Observatory in France, had found that light from both the dark and bright regions of Mars was polarized in a way fairly similar to light reflected from terrestrial volcanic ashes.

Hence the possibility of volcanic activity on Mars deserves consideration. During the favorable oppositions of 1909 and 1911, E. M. Antoniadi, at Meudon Observatory, frequently observed that the Martian feature Deucalionis Regio had a gray color, which he ascribed to volcanic clouds. This is perhaps the first suggestion of volcanism on that planet.

Gray clouds like Antoniadi's phenomenon have been recorded four times by members of the Mars section of the Oriental Astronomical Association: two in 1950 and two in 1952. Moreover, remarkable and unexplained bright points of light have been observed in Japan, one each in 1937, 1951, and 1954. Not all these phenomena may be volcanic in origin, but a statement of the facts in each case appears worth while.

JAPANESE OBSERVATIONS OF GRAY CLOUDS

On January 15, 1950, at 19:00 UT, I detected with my 8-inch reflector at 400x a strange gray cloud at the southern edge of the Martian disk. It was centered at Martian longitude 202°, latitude 58° S., covering Eridania and Electris, forming a circular patch about 750 kilometers in diameter. The cloudlike matter projected slightly beyond the southern edge of the disk; I estimated that it reached a height of 100 to 200 kilometers above the surface of the planet. The color was dull yellow, or rather yellowish dark gray, and the brightness typical of clouds illuminated by sunlight was not seen.

The same night at about 16:30 UT, T. Mitani saw with the Kwasan Observatory 12-inch refractor a cloudlike formation at the southwestern edge of the disk. Furthermore, at 19:40 UT, T. Osawa, observing near Osaka, recorded a dark gray cloud projecting from the southern edge of Mars. Unfortunately, the sky was overcast for some time in Japan, and on February 16th, when Electris and Eridania could be seen again, they had already recovered their ordinary white appearance. Probably the gray clouds which had appeared on January 15th dispersed rapidly.

The second gray cloud was discovered on March 29, 1950, by S. Ebisawa at Tokyo-Tanashi with a 6-inch reflector, power 240, at 10:50 UT. This dark gray cloud covered the southeastern part of Mare Sirenum (eastern Phaethontis Regio). Like the cloud in January, it projected from the southern limb of Mars. Following this strange cloud to about 14:00, Ebisawa watched it carried by the rotation of Mars until it finally disappeared behind the limb. He notified

Sadao Murayama, of the National Science Museum at Tokyo-Ueno, who on March 31st with an 8-inch refractor saw the cloud as yellowish white. On April 2nd I recorded the cloud as changed to dull bluish white.

Two days before Ebisawa discovered the gray cloud, I had noted that this part of Mars was rather bright bluish white. Three weeks after the first appearance, Murayama, Ebisawa, and I all recorded that this region had returned to its normal bright bluish white color. Evidently this gray cloud formed on March 28th or 29th—probably the latter—and turned successively gray-white, dull yellowish white, and dull bluish white, finally returning to the initial bluish white. Like the January cloud, this one also dispersed rapidly.

During February and March, 1952, a third gray cloud was seen in Eridania, south of Mare Cimmerium. The following records were made by Osawa (O) with a 6-inch reflector, and by myself (S) with an 8-inch reflector.

February 4, 1952, about 20:00 UT. Dull white, finally turning to gray (O).

February 5, 21:25 UT. Gray (O); 21:30 UT, dark yellow to yellowish gray, more or less projecting from the limb (S).

March 14, 20:50 UT. Grayish (O); dull white, rather brighter (S).

March 16, 20:50 UT. Appears yellowish white and slightly brighter, but the part of the cloud over northern Eridania is strong gray and shaded (S).

The fourth cloud also appeared in Eridania, and was first seen by Ebisawa on April 16, 1952. An hour before this I had seen this area as rather bright and dark white. At 15:50 UT, Ebisawa noticed that Eridania was covered with dull dark clouds, centered on longitude 210°, latitude 50° S. Watching until after 18:00, he estimated that these gray-white clouds reached about 100 to 150 kilometers above the surface of Mars, judging from their projection. The next night, from 16:00 to 17:30 I saw grayish and dark white clouds covering Eridania; on April 18th from 17:00 to 19:00 UT this region was dirty white, brighter toward the south, but distinctly gray in its northern part.

From these observations it appears that this cloud was rather brighter than those of 1950. It was conspicuous enough to be photographed by Murayama with an 8-inch refractor.

An E. M. Antoniadi drawing of Mars, made November 5, 1909, with the 33-inch refractor of Meudon Observatory. Eridania Regio, the site on several occasions of gray clouds sometimes supposed to be of volcanic origin, can be seen as a lightish patch about half an inch in diameter, to the right and above the center of the disk. The earliest record of Eridania Regio was by J. G. Galle in 1839, using the 9.6-inch refractor at Berlin with which he later discovered the planet Neptune.

Bright Flares on Mars

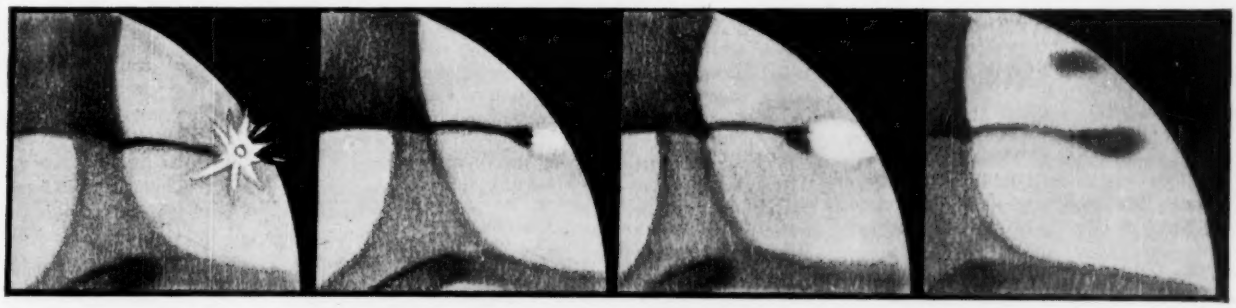
As the late Sizuo Mayeda was observing the canal Alcyonius on June 4, 1937, with an 8-inch reflector, there suddenly appeared near Sithonius Lacus an intense flare spot. This was far brighter than the polar cap or the white clouds of Mars; it scintillated like a star, and disappeared after about five minutes, perhaps because of the planet's rotation.

A second case occurred on December 8, 1951. At 21:00 UT I saw a sharp, bright, glaring spot suddenly appear on Tithonius Lacus. It was as brilliant as a 6th-magnitude star—decidedly brighter than the north polar cap—and shone with scintillation for about five minutes. Fading rapidly, by 21:05 it looked like a whitish cloudlet, as large as Tithonius Lacus. At 21:10 it was barely visible as a very faint and large white spot, and by 21:40 this part of the Martian surface had returned to its normal state.

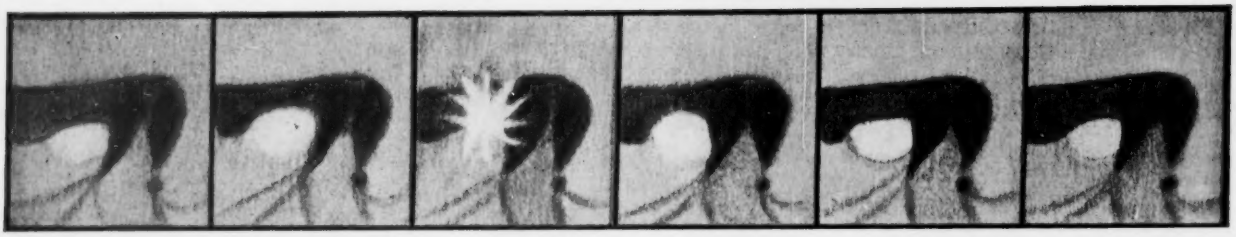
On July 1, 1954, at 13:15 UT I saw Edom Promontorium suddenly brighten, but only about five seconds later it had faded back to its normal appearance—a bright yellow spot. The maximum brilliance of this shining spot was estimated as about half that of the south polar cap. The same night Ichiro Tasaka was observing Mars with a 12½-inch reflector at Shinga City, about 110 kilometers to the south, but he missed this strange phenomenon. He did specifically record that Edom Promontorium looked very bright.

So far, only these three bright flares have been observed by members of the Oriental Astronomical Association. What is the explanation of these strange phenomena?

We can rule out the possibility that these flares were sunlight reflected from a hypothetical water surface on Mars—their locations on the planet with respect to sun and earth preclude this. Reflection from an ice-covered mountainside is free from that objection, but cannot explain the formation of a cloud just after



Successive stages in the flare of December 8, 1951, on Tithonius Lacus. The drawings were made by Mr. Saheki at, from left to right, 21:00, 21:05, 21:10, and 21:40 UT. He used an 8-inch reflector, at 400x.



Six stages in the unusual brightening of Edom Promontorium, July 1, 1954, at intervals of 2, 1, 1, 2, and 2 seconds. The color of this feature changed from yellowish white to very bright pure white, and then back to yellow or yellowish white. These observations are by Mr. Saheki, at 330x and 400x.

the disappearance of the light, as in 1951. A meteorite fall on Mars might produce both light and a cloud, but meets difficulty in accounting for flare durations as long as five minutes, recorded in 1937 and 1951. A fourth interpretation that may be rejected as unreasonable is an artificial origin, for this requires "Martians," of whose existence there is no scientific evidence.

A remaining possibility is volcanic eruptions. These may explain the light and the dust cloud formation. However, the observed duration of the light may be too short, and the probable scarcity of water on Mars may raise difficulties—terrestrial volcanoes eject large quantities of steam.

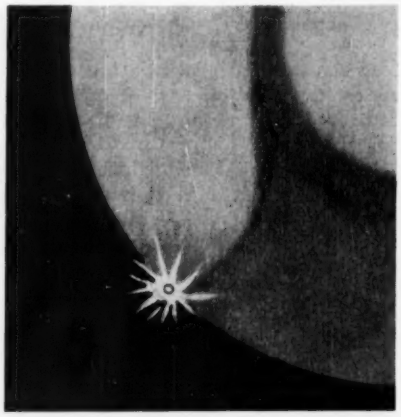
As an observer of Mars, I cannot say definitely at present whether the gray clouds and flares are in any way connected with volcanic activity on that planet. But I am confident of the reality of the phenomena, and believe that future observations will make their nature clear.

COMMENTS BY DR. D. B. MCLAUGHLIN*

Mr. Saheki and his collaborators are to be congratulated on the care with which their observations have been made and reported—and on clearly separating observed facts from interpretation.

The reported great height of the clouds is somewhat surprising at first glance. However, Seymour Hess has pointed out (*Journal of Meteorology*, 7, 7, 1950) that the Martian troposphere may extend up to 45 kilometers above the surface, instead of the 10 kilometers for the earth. Volcanic ash would easily be carried to the top of the troposphere, and, for a great eruption like that of Krakatao in 1883, might well be projected considerably higher. The observers' estimates may be excessive, for a slight irregularity in a regular outline, such as the limb of a planet, can be so obvious to the eye as to be overestimated. Thus a height appreciably less than 100 kilometers for a Martian ash cloud seems not impossible, and may not conflict with the observations.

The bright flares were of enormous intensity compared with any volcanic glare recorded on the earth. It is questionable whether even the 200-inch telescope could show the fire-pit of Kilauea at the distance of Mars, even beyond the planet's terminator. It would certainly not be visible on the illuminated disk. The "fiery cloud" of Mt. Pelee (which destroyed St. Pierre in 1902) was probably two kilometers in diameter and very hot, but not brilliantly glowing. Later clouds erupted by Pelee appeared dull by daylight. The fire-fountain of Vesuvius on August 8, 1779, might have been visible from the moon as a 5th- or 6th-magnitude star. From Mars it would have appeared to be of the 16th or 17th magnitude, at a close opposition. If these Martian flares were volcanic, they would indicate that Martian volcanism is characterized by occasional great outbreaks of incandescent gas a few kilometers in diameter and with temperatures very far above those known in terrestrial volcanism.



Sizuo Mayeda's bright flare on Mars was sketched by him on June 4, 1937, with an 8-inch reflector at 500 power.

Such enormous differences justify considerable skepticism as to a volcanic interpretation. Perhaps it would be worth while to explore the possibility of a solar reflection from oriented ice crystals suspended in the Martian atmosphere—a sort of sun-dog phenomenon in reverse! The slim chance that something of this sort might be involved is suggested by the fact that a whitish cloud was seen.

*Dr. McLaughlin's comments were sent to us when he transmitted Mr. Saheki's manuscript to *Sky and Telescope*.—ED.

LIFE ON OTHER WORLDS

(Continued from page 140)

families of planets," and consequently "life elsewhere in the universe is . . . the exception and not the rule." He points out that while we might find occasional stars with planetary systems, only perhaps one planet in a thousand or a million might support life. Even so, he says, "the total number of worlds that are suitable for life would yet be considerable, so vast is the scale on which the universe is constructed."

We have not as yet actually observed a single real planet outside the solar system—only some faint companion stars whose masses are intermediate between those of Jupiter and the sun. But all the evidence accumulated during the past decade concerning the physical properties of the sun shows that it resembles in all observable respects the billions of other stars in the Milky Way with similar masses and temperatures. We *must* infer that this similarity extends to the manner in which all these stars were formed. It is unreasonable to suppose that one in a thousand or one in a million of these billions of stars underwent a catastrophic process resulting in the formation of planets—without at the same time producing other, *observable* differences in such properties as the axial rotations of the stars.

Since we cannot adduce a proof one way or the other, we must rely upon what seems to be the most logical hypothesis. And this is without doubt the assumption that all, or at least most, dwarf stars of the solar type have planetary systems. The total number of planets in the Milky Way may thus be counted in the billions.

As to how many can support life, we might adopt the solar system as a typical sample. This would give us one out of nine for the kind of advanced organisms we find on earth, and perhaps one out of nine which we might describe with Spencer Jones as "a planet of spent life," and another one out of nine with life in the embryonic state. Thus, the total number of planets with some form of life on them could still be in the billions!

Adventuring in the Virgo Cloud

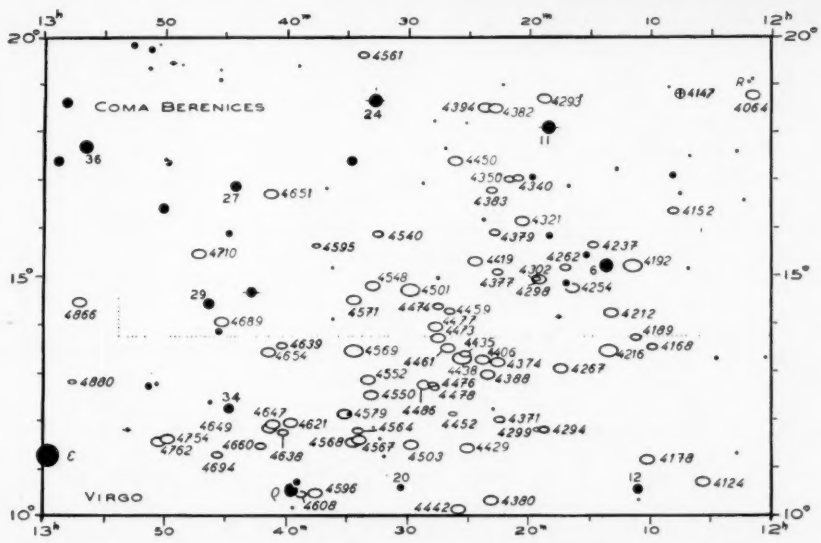
LELAND S. COPELAND

A WONDERLAND surpassing the dreams of fiction writers is hidden in the Coma-Virgo region of the sky, between the stars Vindemiatrix and Denebola. It is the only cloud of galaxies that amateur observers can enjoy.

The Lion guards it on the west and leads it slowly across the sky. Viewed at 9 p.m., it climbs upward during February, March, and April, is on the meridian in mid-May, descends in June and July, and nears the horizon in August.

Though some 3,000 members of the Virgo galaxy cloud have been photographed, only about 30 are within range of a good 6-inch telescope. Astronomers have devoted much time to this cloud, but few amateurs have become acquainted with even its more conspicuous members. Looking like shadows in the dark, these wonders wait 20 million light-years from Earth.

This double galaxy in Virgo has been called the Siamese Twins by the author. NGC 4567 is the upper spiral; NGC 4568 is the lower. North is at the top in this enlargement of a 6-hour exposure with the 60-inch Mount Wilson reflector.



This chart shows the galaxies brighter than visual magnitude 12½ in the Coma-Virgo region. Each galaxy is identified by its NGC (New General Catalogue) number. Dots denote stars down to magnitude 7.75. In the upper right corner, the crossed circle represents the globular star cluster, NGC 4147. Adapted from the Skalnate Pleso "Atlas of the Heavens."

How can the owner of a common telescope get to know these objects, so small, so dim, and so far away? On larger instruments (8-inch and 10-inch), setting circles will help, but the circles of portable and smaller amateur telescopes are rarely accurate enough. Instead, a detailed touring map is needed, with shining signposts and with star trails leading from one galaxy to another. Because there has been no such map, one has been made for this article (see page 148).

Why should we bother to look at these galaxies, which are often hardly discernible in amateur telescopes? Not for what they seem to be, but for what they are: each a distant Milky Way, seen by light millions of years older than prehistoric man. They can help us gain true perspective—we and our world are the minutiae

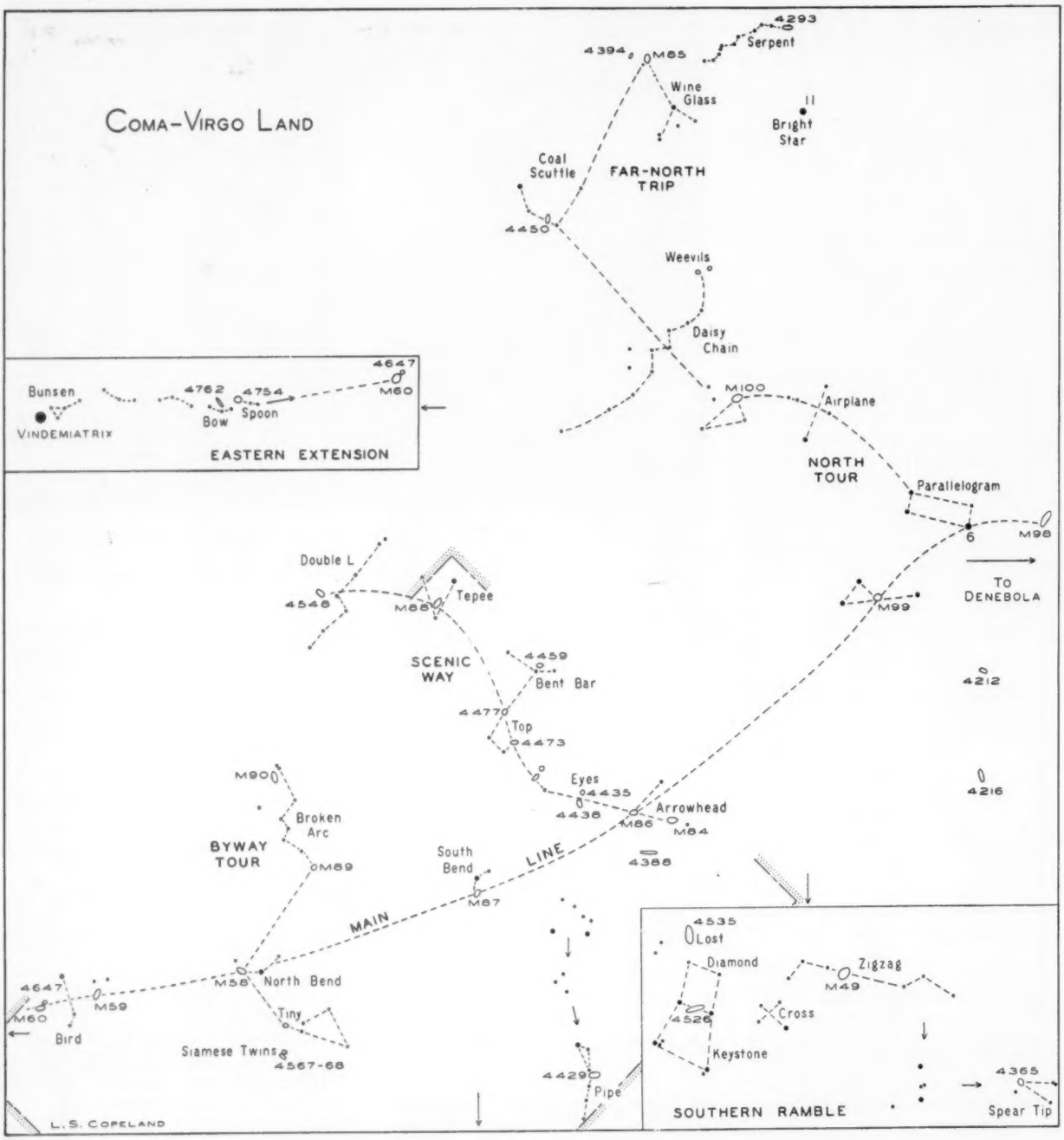
and curiosa—galaxies are the grand realities. Thoughts like these explain why some amateurs pass leisure hours hunting for tiny, misty spots near the north and south galactic poles, where the galaxies are seen in greatest numbers.

Camille Flammarion, French astronomer, whose name is given to a large lunar ring, had this imaginative outlook. For four years he was assistant to Leverrier, the co-discoverer of Neptune. As explained by Hector MacPherson, the young astronomer was troubled by Leverrier's disinterest. The assistant's queries about inhabited worlds and varied colors of double stars were coldly received by the great mathematician. "In his opinion," commented Flammarion, "essential knowledge consisted of equations, formulae, . . . velocities and forces."

Amateurs emotionally akin to Flammarion are drawn to fields of galaxies on clear, dark nights. For us those hazy blobs and splinters of light are among the major details of existence.

To find and identify the 30 or more brightest galaxies in Virgo and Coma Berenices, right ascension and declination circles are helpful but not necessary. Sweeping for galaxies calls for physical and mental perseverance, because catching a galaxy, like catching a fish, may need many minutes of patient effort.

When a galaxy has been brought in, the amateur should find a star trail leading to it, as a woodsman marks a way through a forest, or should notice a design in the surrounding stars. So he will become acquainted with locations, and



A tourist map of star trails to the brighter galaxies in Coma-Virgo land. North is at the top. Galaxies are identified by their NGC or Messier (M) numbers. The shadings loc ate the edges of the photograph on pages 150-151.

more easily can return to them a month or a year later.

The coined names used in the accompanying map are new to astronomy, but a precedent has been set by Lord Rosse, of 19th-century fame, who selected the fanciful terms, Crab, Owl, and Dumbbell, for three well-known planetary nebulae.

Two bright markers fix the east and west limits of the heart of the Virgo assembly, Vindemiatrix (ε Virginis) and Denebola (β Leonis). Stars in our own Milky Way system, they mark the sidelines of an imaginary frame through which we see this wonderland of other galaxies. Between these stars there curves what may be called the Main Line. A good place to start is about midway along this, where two of the easier objects lie, M84 and M86. With a star shown on the map, these elliptical galaxies form the Arrowhead, with M86 at the point. It is a useful skymark.

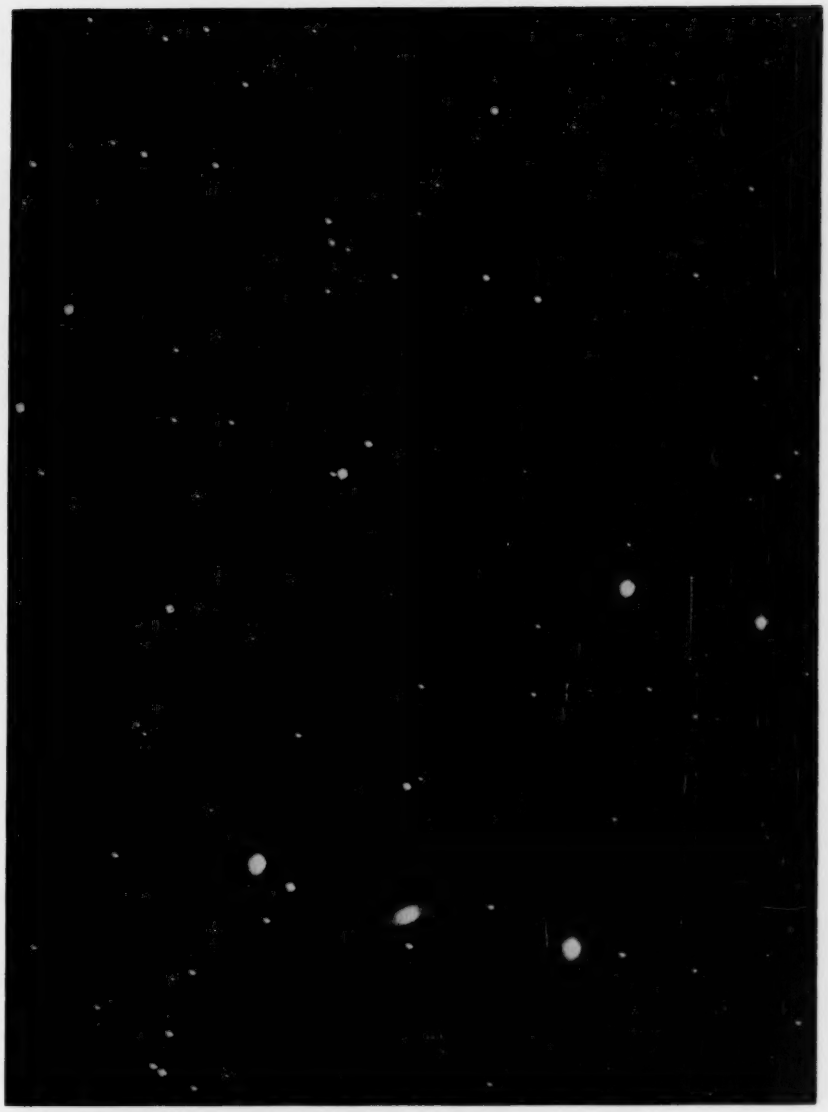
Sweeping eastward, we pass through M87, at South Bend, and M58, at North Bend, to M59 and M60, two ellipticals, which with some stars form the Bird—three fourths of the way from Denebola to Vindemiatrix. Close to M60 is NGC 4647. Continuing on the Eastern Extension, shown in the inset, we can reach NGC 4762, halfway between the Bird and Vindemiatrix. It lies within an arc of three stars, the Bow. A somewhat difficult edge-on object, NGC 4762 is handsome in a 16-inch telescope.

An alternate way to find this galaxy is to proceed from ε Virginis itself, over a star trail beginning with the Bunsen, an asterism of four fine stars. The Eastern Extension inset shows two arcs of stars that lead from the Bunsen to the Bow. Near this is the Spoon, two faint stars and a roundish spiral, NGC 4754. Passing westward from the Spoon, along a line pointing from the Bow through the top of the Spoon handle, we return to M59 and M60.

From M58, let us try the Byway Tour, all of which is shown on the Harvard Schmidt photograph on pages 150 and 151. It leads us northward to M89 and M90, at the end of a Broken Arc of stars. And let us go southward to the Siamese Twins, NGC 4567-68, a very dim spot in an 8-inch telescope. Just north of this double system is Tiny, NGC 4564, another galaxy; it is diagonally above and to the right of the Twins on the Schmidt photograph, where the orientation is with the north-south direction at a 45-degree angle.

Southwest of M87 a bent trail leads through a keystone of stars, then south through a triangle and on to NGC 4429 in the Pipe. This is at the lower edge of the Schmidt field.

Now let us try the Southern Ramble, shown in the lower inset of our touring map. The arrow above the inset corresponds to the arrow at the edge of the main map, south of M87, but the distance is greater than shown here. About midway between ε and π Virginis, in a long Zigzag of stars, lies M49, another elliptical. From the western end of this Zigzag, a star trail leads to NGC 4365 and the Spear Tip; the course to follow here is indicated by arrows on the map. The Cross below the eastern end of the Zigzag is faint, but it aids in locating the Diamond, with the galaxy NGC 4526 between two corners. North of the Diamond is a very dim spiral, here called the Lost Galaxy, NGC 4535. In the accompanying picture, these two objects are shown as larger telescopes see them.



Two spirals along the Southern Ramble. Above is the Lost Galaxy, NGC 4535, whose delicate structure shows only on long-exposure photographs. Below, between two stars of the Diamond, is the nearly edge-on galaxy NGC 4526. North is at the top of this enlargement of part of a photograph taken with Harvard Observatory's Jewett telescope.

If we had time we could go still farther south to M61, a barred spiral, between δ and ν Virginis and forming a right triangle with γ and η. M61 and four dim stars make a pattern suggesting the Northern Cross.

Returning to the Arrowhead (M84 and M86), which in the telescope points upward in spring and downward in summer, let us travel northeastward over the Scenic Way, through the dim Eyes (NGC 4438 and 4435), past the Top, made up of two galaxies and two stars, to M88, in a group of stars forming the Tepee. M88 is in the upper right corner of the large picture, which also includes NGC 4459 in the Bent Bar. Outside of the field is the Double L at the end of the Scenic Way, where NGC 4548 is located.

About a third of the distance from De-

nebola to Vindemiatrix is a small starry Parallelogram, with the star 6 Comae Berenicis at one corner. This asterism is a helpful signpost for the North Tour in Coma. Southeast of it is a stellar triangle with an outrider star, and at the western corner of this triangle appears M99. West of the Parallelogram is M98, a dim edge-wise system.

Northeasterly from our signpost, we can find a stellar Airplane and M100. Farther east is the Daisy Chain, a long irregular line of stars ending in the Weevils, two distant sidereal systems that appear very tiny in the telescope. Beyond this chain, to the northeast, is a group of stars, the Coal Scuttle, with another galaxy, NGC 4450, at its bottom.

The writer's imagination tells him that in most galaxies there should be other inhabited worlds. True, Sir James Jeans pointed out that nature seems to be more interested in physics than in biology, and he and Sir Arthur Eddington were inclined to regard life as incidental and accidental. Yet each galaxy has so many stars that even exceptional worlds can be numerous in these galaxies scattered across Coma-Virgo Land.

From the Coal Scuttle, we take the Far-North Trip to M85. This object is very friendly and keeps bobbing up in the field of the telescope. It forms a triangle with a star and a faint galaxy at the foot of the Wine Glass, a configuration of four or five stars. Relatively near is the Serpent, a dim stellar line, with an elliptical system, NGC 4293, at its head. A marker for this region is the bright star 11 in Coma Berenices. To the left of M85 is NGC 4394.

Those who wish to wander beyond the area of the map, within the stellar fan made by α and β Comae Berenicis and the elongated curving cluster that commemorates the lost tresses of Berenice, may pick up M64 and NGC 4565, noteworthy specimens. The latter is photographically the fairest edge-on system in the northern hemisphere of the sky, but it is surpassed in amateur telescopes by NGC 4631, halfway between Cor Caroli and γ Comae at the northwestern corner of the fan.

Whoever can become acquainted with 20 or more of these dim "universes" will have enjoyed a unique experience—a sky adventure in a vacation land quintillions of miles away. Despite the misty, light-filled air of a seaside city on the West Coast, I have been able to make this far

FEATURE PICTURE: Part of the Coma-Virgo region, enlarged from a 74-minute exposure made on March 19-20, 1947, with the 24-inch Jewett telescope. To match the orientation of the charts on pages 147 and 148, this picture should be turned counter-clockwise through 45 degrees; then north will be on top. Along the right edge runs the Scenic Way, at whose lower end are the two bright elliptical galaxies M86 and M84, the latter nearer the edge. These form part of the author's Arrowhead. The spiral M88 is in the extreme upper right corner. In the upper left, the pair of galaxies M60 and NGC 4647 is easily recognized, as is M90 near the mid-point of the upper edge. Harvard Observatory photograph.

journey successfully by using an 8-inch Cave reflector and 32-mm. and 16-mm. Brandon eyepieces. As an aid to observing, I had photographs with identifications from Lick Observatory, and these were used in constructing the touring map.

All of these marvels were unknown to the ancients, who thus made what today seem odd surmises about the universe. Knowledge of the galaxies can save us from a narrow philosophy as we ponder the riddle of existence. We no longer can believe that the earth is unique or in the spotlight.

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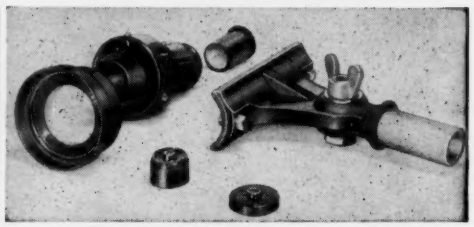

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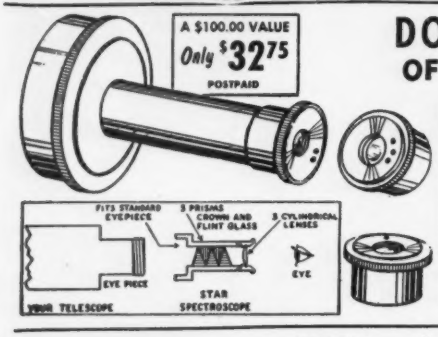

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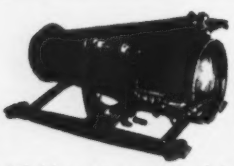

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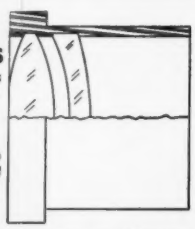

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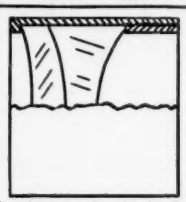

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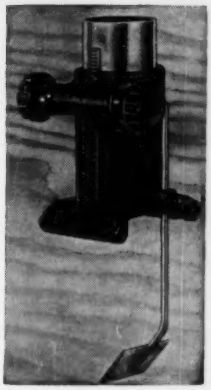

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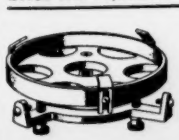

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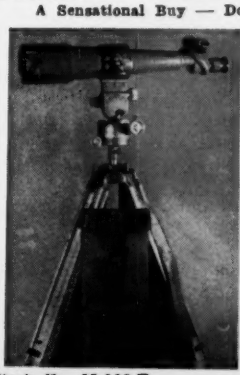

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BOOKS AND THE SKY

SPACE TRAVEL

Kenneth W. Gatland and **Anthony M. Kunesch.** Philosophical Library, New York, 1953. 205 pages. $4.75.

THIS COMPACT volume relates the history of rocket development, the accomplishments of recent rockets, and the possibilities of rocket travel in the not-too-distant future. It concludes with a long view ahead that should fire the imagination of the most enthusiastic "space man."

Space Travel begins with a concise account of rockets from the discovery of explosives before the time of Christ to the flight of Goddard's first liquid-propellant rocket at Auburn, Mass., in 1926. It tells of the use of rockets in warfare and in carrying life lines at sea.

In the second chapter, we are told of the rapid developments by members of the German rocket society and, with the advent of Hitler, by the Army Weapons Department. From a 1931 firing that reached 60 feet to the 12½-ton V-2 that attained a height of 107 miles is a fascinating story, enhanced by the realization that the latter was Vengeance-weapon Two against which the Royal Air Force made its famous Peenemunde raid, killing 1,000 men during the night of August 17-18, 1943.

Many types of rocket motors and propellant mixtures are described, and the postwar American work leading to the release of a WAC Corporal from a V-2 to reach a height of nearly 250 miles concludes the chapter.

Expressing the opinion that man will almost certainly visit other worlds before the end of the century, the authors discuss some problems of space travel. Can man endure long intervals of zero gravity? What are the dangers from meteorites and primary cosmic rays? Questions concerning fuel, food, temperature, oxygen and water reclamation, and landing craft, are taken up.

The artificial satellite is the next concern of the authors, who emphasize that manned rocket flight will be almost commonplace before any attempt is made to reach another world. The great advantage of artificial satellites in research rather than in warfare is stressed, and the ease of destroying a satellite is contrasted with the vast difficulty of establishing one.

Gatland and Kunesch do not expect spaceships to come suddenly, but rather as the result of gradual developments in many fields. Among the various lines of research that will eventually make the first spaceship possible, they cite as an example upper-air research with rockets such as the Viking. There is also the research in aerodynamics at supersonic speeds, carried out at Wallops Island off the Virginia coast—of much help in designing the Douglas Skyrocket and other supersonic planes. Pressure suits for use at high altitudes have been made. The human centrifuge at the Aviation Medical Acceleration Laboratory at Johnsville, Pa., can attain a stress of 40 times gravity in less than seven seconds.

Types of possible atomic rocket motors are described and illustrated. Since the application of atomic energy is in its infancy, there is great hope that a suitable motor will be developed to drive the first spaceship out to other worlds, *and back.*

"Operation in Space" is a chapter where some hard facts are encountered. The impossibility of leaving the earth with a single-stage chemical rocket is made obvious, and the three-stage rocket is explained. A freight rocket capable of delivering five tons of material to an artificial satellite would have to weigh 510 tons initially. And there is still the problem of returning to earth from the satellite; a vehicle weighing 740 tons is suggested.

After a discussion of possible launching sites on the earth, a prophetic account is given of the departure of the first man-carrying rocket. "Operation Luna," the establishing of a base on the moon, is described, as well as trips to Venus and Mars. A 969-day expedition to Mars and back should be possible with chemical multistage rockets, but the magnitude of the task suggests that the application of atomic energy will come first.

In the final chapter, even the stars are considered as possible destinations for future spaceships. It would require more

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than 130,000 years to reach the nearest star with a chemical rocket, but an atomic one might need only 350 years. The authors suggest harnessing an asteroid or artificial planet on which generations of people might live and die while the small world speeds toward another star! The possibility of attaining speeds approaching that of light by the annihilation of matter is pointed out.

The book is well illustrated with real and imaginary pictures. Some drawings suffer from too much reduction in size. Many typographical errors indicate a speed in production approaching that in rocket development. Amateur astronomers will take some of the astronomical statements of the final chapter, such as that the farthest naked-eye star is 600 light-years away, with caution. It might be well to point out that the footnote on page 170—stating that the moon's gravitational pull is one sixth the earth's—applies only to the surfaces of these objects.

N. E. WAGMAN
Allegheny Observatory

NEBULEUSES GALACTIQUES ET MATIERE INTERSTELLAIRE

Jean Dufay. Editions Albin Michel, 22 Rue Huyghens, Paris 14e, 1954. 492 pages. 1,650 francs, paper bound.

IN THE LAST few years, our knowledge of the interstellar medium has increased at a rate hardly paralleled before in any other branch of astronomy. The rapid succession of observational discoveries and their theoretical interpretations seems to indicate that we now understand, with some degree of completeness, the physical processes operating in the interstellar medium.

The appearance of Dr. Dufay's book, summarizing and methodically arranging what we know so far about matter in interstellar space, could thus not be more opportune. Until now, the literature on the subject has been restricted to scientific journals, and was accessible only to the specialist. The clear and simple style of this book, which omits the mathematical scaffolding of the theory, will make it attractive to astronomers, nonspecialized scientists, and serious amateurs alike. I have already recommended it as preliminary background reading to the students in my graduate course on interstellar matter.

Following an introduction containing some fundamental astrophysical concepts, the book is divided into four parts. First, Dufay describes how the interstellar gas is observed and discusses the interpretation of these observations. The next part deals with solid particles, and includes a general account of the theory of particle optics. The third part treats the interrelation of solid and gaseous matter, and presents certain views on star formation. A chapter on the interstellar polarization of starlight is included in this part, although logically it would seem to belong to the preceding one. The last section discusses interstellar matter in relation to the constitution and structure of external galaxies.

If any criticisms of the treatment are to be offered, they concern phases of the subject that should still be considered as preliminary hypotheses or mere suggestions. The author himself impartially emphasizes the points that are still open to debate.

The illustrations are numerous, with 24 halftones that include various nebulae and Milky Way fields, and 51 line drawings. The originals of the photographs were obtained with the rather moderate-sized instruments available in France. Nevertheless, their high quality again speaks for the traditional carefulness and ability of the French observational astronomers. The usefulness of the book is enhanced by an extensive bibliography.

GUIDO MUENCH
Harvard College Observatory

NEW BOOKS RECEIVED

DESIGN OF THE UNIVERSE, *Fritz Kahn*, 1954, *Crown Publishers*. 373 pages. $5.00.

Writing for the layman, Dr. Kahn describes the world of modern physics and its picture of space, time, matter, and radiation; the astronomical universe with special reference to the solar system; and the earth and the geological processes that shape its surface.

THEORY OF THE ROTATION OF THE EARTH AROUND ITS CENTER OF MASS, *Edgar W. Woolard*, 1953, *U. S. Government Printing Office*, Washington 25, D. C. 165 pages. $1.65, paper bound.

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nutation—are of fundamental importance in the precise determination of time and of star positions. The formulae currently used for the nutation no longer meet present-day requirements. Nutation formulae of sufficient accuracy are developed by Dr. Woolard in this publication. They will be used in the *American Ephemeris* beginning with the volume for 1960.

This work forms Vol. 15, Part I, of the *Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac.*

ANCIENT SCIENCE AND MODERN CIVILIZATION, *George Sarton,* 1954, *University of Nebraska Press.* 111 pages. $2.50.

Greek science and mathematics are the subjects of the Montgomery lectures given in 1954 at the University of Nebraska by Dr. Sarton, and printed with notes in this volume. The three lectures dealt with "Euclid and his Time," "Ptolemy and his Time," and "The End of Greek Science and Culture."

THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC FOR THE YEAR 1956, *Nautical Almanac Office,* U. S. Naval Observatory, 1954, *U. S. Government Printing Office,* Washington 25, D. C. 644 pages. $4.00.

The 1956 volume of the *American Ephemeris* does not differ in plan from that for 1955. Among its contents are accurate ephemerides for the sun, moon, the planets from Mercury through Pluto, and the first four asteroids; extensive predictions are given for eclipses, occultations, and satellites; and there is much additional material useful to observers and computers.

EXPLORING MARS, *Robert S. Richardson,* 1954, *McGraw-Hill.* 261 pages. $4.00.

A staff member of the Mount Wilson and Palomar Observatories has written this account of Mars for the general reader. Somewhat more than half the book is devoted exclusively to the red planet; the remainder describes the moon and other planets, and discusses the possibilities of space travel.

OUR AMERICAN WEATHER, *George H. T. Kimble,* 1955, *McGraw-Hill.* 322 pages. $4.75.

The 12 chapters of *Our American Weather* describe for each month of the year the weather of the United States in easy-to-read language. Into this pattern are fitted discussions of everything from the why of the rainbow to man's ability to control the weather.

ALL ABOUT THE STARS, *Anne Terry White,* 1954, *Random House.* 144 pages. $1.95.

Mrs. White tells about the sun, moon, and planets, and about stars and systems of stars. In simple language, topics from the invention of the telescope to supernovae are woven together. The jacket states that the book is for boys and girls aged 10 to 14.

SONG OF THE SKY, *Guy Murchie,* 1954, *Houghton Mifflin.* 438 pages. $5.00.

Wind and weather as seen by the air navigator form Mr. Murchie's theme, with many diversions into subjects like how Columbus navigated, record rainfalls, unusual accidents to planes, the why of rainbows. This is a Book-of-the-Month Club selection.

A GUIDE TO THE PLANETS, *Patrick Moore,* 1954, *Norton.* 254 pages. $4.95.

Writing for the layman and the amateur astronomer, the author of *A Guide to the Moon* describes the planets and their satellites, including some observational results too recent to be widely known. Appendices give practical advice to the planetary observer and suggestions for further reading.

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(See page 168 and the back cover)

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GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

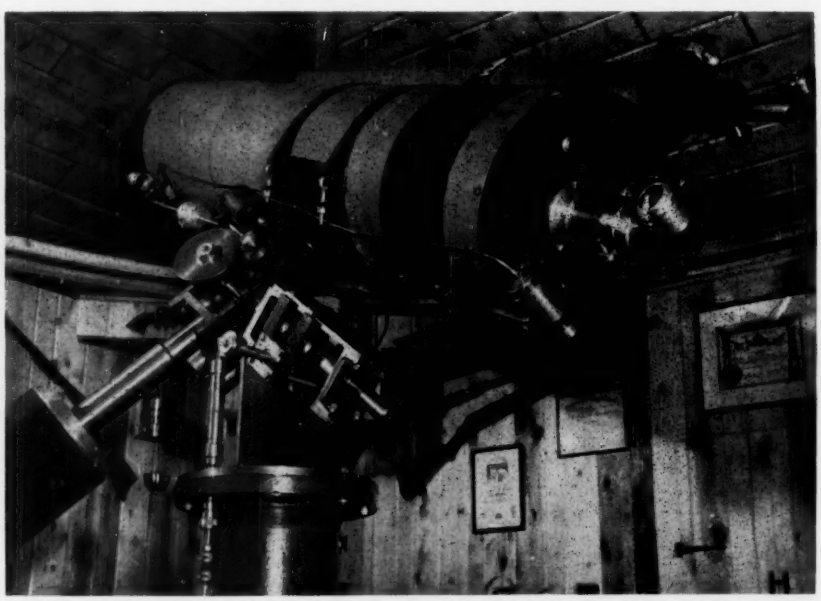
The Doreddie Observatory

DOREDDIE Observatory began in 1926, when the writer built a 6-inch reflector from the directions in the first thin volume of **Amateur Telescope Making.** Then came a succession of other reflectors, a 4-inch, another 6-inch, and a 9-inch, and several small refractors. In 1950 I decided to add a second-story room to my home for a combined den and observatory. This room, 14 feet square, is well lighted by three large windows, and can be reached from the ground floor by a circular stairway. The pyramidal dome is the B1 type described in **Amateur Telescope Making, Book Two.** It revolves on 1" steel balls that roll between two 1" steel channels. Celotex spacers hold the balls 10" apart, and are grooved top and bottom to fit the flanges of the channel tracks, forming a perfect weather seal. Shutters and dome are electrically operated by two buttons on the guiding head.

The principal instrument is a 12½-inch Newtonian-Cassegrainian reflector (see the front cover). This is on a pier that extends to the ground through a partition to the house, and is steady as a rock. After the optical parts were obtained from Fred B. Ferson, the big problem was a suitable mounting. Since most mounts for telescopes of this size have large castings and require sizable equipment for their machining, and since my shop has only a small 6-inch engine lathe, power hacksaw, and a grinding head, a design had to be worked out using what was available.

The axes are both 2½" cold rolled steel, and are mounted in steel boxes made of plate and channels. The cut-down stub end of the polar axis has been left to take a setting circle. Inside the boxes are brass worm gears, through which the telescope is friction-driven, the amount of friction being determined by the pressure of the worms on the gears. There are no clutches, so that the telescope can be moved by hand at any time; once it is set, the drive takes over. Triangular gear teeth, cut on a lathe, and well-fitting bearing seats have completely overcome the backlash problem.

The drive is a rather simple motor-gear combination. The large picture shows the drive shaft that passes up from the control panel through the flange at the top of the pier, to a worm which engages a small gear on the same shaft with the principal worm that drives the telescope. The driving speed is controlled by a carbon-pile rheostat, and this works well enough to hold an object in a 450x field for several hours. Provision has been made for a controlling clock. Both drive and right-ascension slow motion use the same motor. The declination slow motion is similar, but I took its motor apart and balanced the armature so there would be no vibration. The declination motor may be seen just below the telescope saddle. The shaft carries a small pulley on the end, and a belt engages the larger pulley just below this. To gain further reduction, this pulley drives a worm which engages the large gear mounted on the



Some details of the mounting, drive, and novel focusing device of E. D. Onstott's 12½-inch reflector may be seen here. Star diagonals are used on the telescope and finder. All pictures with this article are by E. D. Rickords.

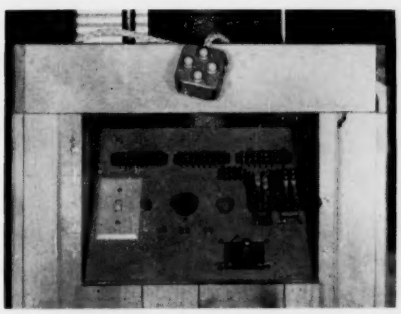
The secondary support and focusing mechanism are seen here. The spiral is part of the hydraulic line from the bellows at the back of the mirror cell.

declination-axis box. This in turn is on the same shaft with a worm that drives the gear on the declination axis itself.

The mounting as a whole is simple, except perhaps for the wiring. Sometimes I follow Murphy's Second Law: "If you can make a thing more complicated, do it!" From the appearance of the back of the control panel, I would not be surprised to look through the telescope some night and see Channel 5.

A hydraulic system moves the secondary mirror for focusing. This works through two hermetically sealed aneroid bellows connected by copper tubing. The transmitter bellows is mounted within easy reach of the eyepiece, as may be seen in the larger photo. It is controlled by a screw, and the receiver bellows moves the secondary accordingly. More detail of the receiver bellows shows in the closeup of the upper end of the tube. Although there is also a conventional rack and pinion on the eyepiece end, the ease and smoothness of the hydraulic focusing leaves nothing to be desired.

The entire secondary mechanism is easily removable from its supporting ring, which then becomes the support for the Newtonian diagonal or prime-focus plateholder. There are two finders: a 4-inch refractor which serves as a guiding



The telescope control panel is set in this frame. Hanging over the top is the hand-held guiding head, with push buttons for the slow-motion controls.

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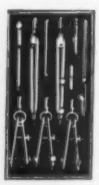

Made in Germany, of heavy brass, nickel plated and polished. Instruments include 5⅛" Compass with pencil and pen points and lengthening bar. 5⅛" Divider, three 3¾" sidewheel Bow Dividers with needle point, pen point and pencil point. 5" Ruling Pen, extra handle for pen or pencil, capsule with extra leads. Interchangeability of these many parts makes this an exceptionally versatile set. Your money back—if this set is not worth twice our price!

F-13.....NET 2.75

NEW POCKET AC-DC VOM MULTITESTER

This instrument is one of the best buys that Lafayette has ever offered in a Wide Range AC-DC MULTITESTER. An ideal portable unit that meets the need for a compact, yet rugged test instrument. Has ease of operation usually FOUND ONLY IN MORE EXPENSIVE INSTRUMENTS. Has 1000 ohms/volt sensitivity on both AC or DC. Uses full 3" rectangular meter with large, easy to read scale. Uses 1% precision resistors, jeweled D'Arsonval microamp meter movement. Ranges: AC-DC and output volts 0-5, 0-25, 0-250, 0-1000V; DC current 0-1, 0-10, 0-100 DC, MA: Resistance 0-10K and 0-100K ohms. In handsome sturdy bakelite case. Size: 4¾" x 3¼" x 1⅜". Supplied Complete with test leads and batteries. A Must for every serviceman, shop, laboratory or experimenter—and at Lafayette's price you can afford to own one. Shpg. Wt. 2½ lbs.

MODEL RW-27C—Complete..In lots of 3 9.45
Singly, ea. 9.95

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IMPORTED DIRECT
COATED LENSES
PRISM
BINOCULARS

- All-metal construction
- Individual focus
- Complete with leather case and straps

F-105, 8 x 30 with case.....Net 19.95
F-15, 7 x 35 with case.....Net 22.50
F-103, 7 x 50 with case.....Net 24.95
F-104, 12 x 50 with case.....Net 32.50
with order, Add 10% Fed. Tax

BAROMETER

- Handsome Styling
- Precision Movement
- Reads 26 to 32 Inches

Produced in Germany by expert craftsmen — unquestionable quality — unbelievable price! Calibrated in 1/100", 1/10" and inches from 26" to 32". Ivory porcelainized metal scale with black and red lettering reading: Stormy — Rain — Change — Fair — Very Dry. Richly polished mahogany stained hardwood case. Black indicator arrow shows atmospheric pressure. Brass arrow sets for reference reading to show degree of change. Polished brass bezel, plano crystal face, open dial reveals intricate mechanism. 5¼" in diameter by 1½" deep. Tells weather 12 to 24 hours in advance.

F-11.....NET 3.95

IMPORTED TWIN LENS CAMERA

2¼ x 2¼ NEGATIVES
With F3.5 Coated Lens
Shpg. Wt. 7 lbs.

A 69.50 VALUE!
only at Lafayette

- Built-in Flash Synchronization
- Fingertip Focusing
- Sportsfinder
- 9 Speed Shutter 1 to 1/200 Sec.
- Double Exposure Prevention
- Matched Coated Lenses are Coupled in Helical Mount
- Accepts 120 Roll Film

Stock No. F-32 29.95

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BOSTON, MASS. 110 Federal St.

Include postage with order

telescope, and a 5x elbow telescope with illuminated crosshairs.

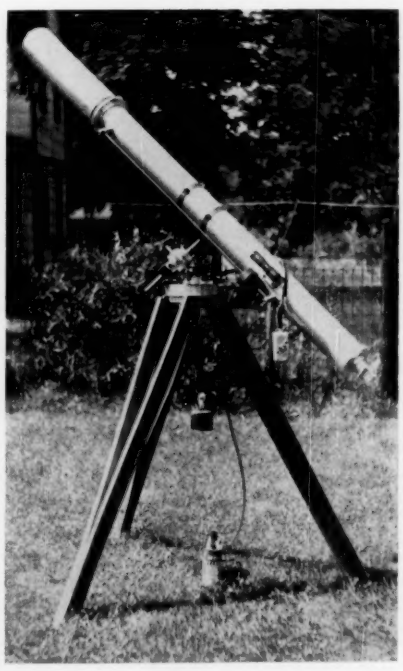
There has been no end to the satisfaction I have gained from the use, both by others and myself, of the facilities at Doreddie. Since the observatory was first opened in May, 1951, over 300 names have been entered in the guest register. Visitors are always welcome.

E. D. ONSTOTT
2421 Second Ave.
Pueblo, Colo.

A CLOCK-DRIVEN PORTABLE REFRACTOR

MY SPARE TIME during the past four years has been spent in building the 4-inch refractor described here. It is now complete except for a guiding telescope and declination slow motion. The objective, purchased from Chester Brandon, has a clear aperture of 4", and a 63" focal length. The star diagonal is a war-surplus Amici roof prism, giving an erect image. Only one eyepiece is used, a 32-mm. orthoscopic, but the position of the Barlow lens can be varied to give magnifications from 50 to 450. The weather around South Bend keeps me from using over 300x except on very rare occasions.

The aluminum main tube is 55" long, with a wall thickness of 5/16". It was turned and threaded at both ends in a large lathe. Welded steel was used for the objective cell, since in aluminum it would have had to be specially cast at considerable cost. The dew cap, made of seam-welded 1/16" rolled aluminum, extends 18" beyond the lens. Even on the dampest nights I have not been bothered



This 4-inch refractor, built by Richard Foltz, is weight driven, and has a battery-powered slow-motion control.

LARGE OBJECTIVES

ACHROMATIC TELESCOPE OBJECTIVES

These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. They are fully corrected and have tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100 and more.

Diameter	Focal Length	Each	Diameter	Focal Length	Each
54 mm (2⅛")	300 mm (11.811")	$12.50	83 mm (3¼")	660 mm (26")	$28.00
54 mm (2⅛")	330 mm (13")	12.50	83 mm (3¼")	711 mm (28")	28.00
54 mm (2⅛")	390 mm (15.356")	9.75	83 mm (3¼")	762 mm (30")	28.00
54 mm (2⅛")	508 mm (20")	12.50	83 mm (3¼")	876 mm (34½")	28.00
54 mm (2⅛")	600 mm (23½")	12.50	83 mm (3¼")	1016 mm (40")	30.00
78 mm (3 1/16")	381 mm (15")	21.00	110 mm (4⅜")*	1069 mm (42 1/16")	60.00
81 mm (3 3/16")	622 mm (24½")	22.50	110 mm (4⅜")	1069 mm (42 1/16")	67.00

*Not coated

• We can supply ALUMINUM TUBING for the above lenses. •

3X ELBOW TELESCOPE

Makes a nice low priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, and light weight, 2 lbs.

Gov't. Cost $200.

Plain Optics **$9.75** Coated Optics **$12.50**

FIRST SURFACE MIRRORS

Size	Thickness	Postpaid
14" x 16"	¼"	$10.00
8" x 10"	¼"	4.25
4" x 5"	¼"	1.85
4" x 4"	¼"	1.50
1¼" x 1½"	1/16"	.25

SMALL SPECIALIZED TELESCOPE

1⅛ power, 5½ inches long, solid brass construction, weight approximately 1 lb. Contains an objective lens, mounted Porro-Abbe erecting system and an achromatic eyepiece which was designed for good eye relief. Eye distance 4". **$4.50**

8X ELBOW TELESCOPE

This telescope will make an exceptional finder. Objective 52 mm diameter. Focusing eyepiece, turret-mounted filters, amber, red, neutral, and clear. Illuminated cross-line reticle, quick-finding level sight, and large-size Amici prism.

Used ....**$18.50** Brand New **$27.50**

7 x 50 MONOCULAR

Of the same high quality as our binoculars. Many observers find them ideal as rich-field sky sweepers or as telescope finders. Brand new, coated optics, complete with genuine leather plush-lined carrying case and straps. 7 power; objective is 50 mm in diameter. **$17.50**

6X BATTERY-COMMANDER PERISCOPE

Made of brass. Has focusing eyepiece and crossline reticle. Weight 3½ lbs., length 28".

Postpaid **$15.00**

Geared mount and sturdy tripod for the above are available. Write for the low price.

OPTICAL PEEP SIGHT

Use as a camera view finder and for similar purposes. The image appears on a bull's-eye reticle. There is no parallax for any distance. The same principle is commercially used by shotgun-sight manufacturers. The diameter is 37 mm. Weight 1½ oz. Gov't. cost $10.75.

Our price ..... **Postpaid $1.00**

AN ECONOMICAL EYEPIECE

This mounted eyepiece has two perfect magnesium-fluoride lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube . **$4.50**

40-POWER TELESCOPE With Tripod

For stargazing and terrestrial use. It gives an upright image. Large coated achromatic objective 60-mm diameter. Tripod constructed of wood with brass extension tubes. Tube 22" when closed, 56" fully extended. Swivel mount can be locked in any position. **$39.75**

LENS CLEANING TISSUE—Here is a wonderful Gov't. Surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications.

500 sheets size 7½" x 11" .. **$1.00**

"GIANT" WIDE-ANGLE EYEPIECE

Known among amateurs as the **"Giant Jaegers"**, this is the finest wide-angle eyepiece ever made. It gives a flat field. It is mounted in a focusing cell. This is an Erfle eyepiece, 1⅛" effective focal length, with a clear aperture of 2 3/16". It may be used as a Kodachrome viewer, magnifying seven times.

$125.00 Value **$18.50**

BRAND NEW COATED 1¼" E.F.L. wide-angle eyepiece. Contains 3 perfect achromats. Aperture is 1-3/16". (Illustrated)

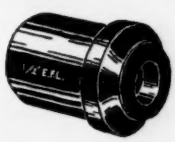
$13.50

"MILLIONS" of Lenses, etc. Free Catalogue

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 10 days.

MOUNTED EYEPIECES

SUPERIOR QUALITY SUPERIOR WORKMANSHIP THEY CAN'T BE BEAT!



We have a large stock of precision war surplus lenses, and have mounted them in precision mounts of 1¼" outside diameter, the standard for telescopes. Result! You would pay several times more elsewhere. Our prices can't be beat.

12.5 mm (½") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$6.75** Not coated **$6.00**

16 mm (⅝") F.L. extra wide angle Erfle contains five lenses.
Coated lenses **$13.50** Not coated **$12.50**

16 mm (⅝") F.L. triplet eyepiece contains a three-element lens and a simple lens.
Coated lenses **$13.50** Not coated **$12.50**

18 mm (¾") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$6.75** Not coated **$6.00**

22 mm (27/32") F.L. Kellner eyepiece contains cemented achromat and a non-achromatic lens.
Coated lenses **$6.75** Not coated **$6.00**

32 mm (1¼") F.L. eyepiece contains two achromatic lenses.
Coated lenses **$13.50** Not coated **$12.50**

35 mm (1⅜") F.L. symmetrical eyepiece contains two cemented achromats.
Coated lenses **$8.75** Not coated **$8.00**

55 mm (2 3/16") F.L. Kellner eyepiece contains achromatic field lens and a non-achromatic eye lens.
Coated lenses **$6.75** Not coated **$6.00**

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INFRA-RED TUBES

See in the dark!

Famous British simplified types. Make your own infra-red telescopes. Complete booklet showing easy construction methods, included with each tube. Tubes won't last long at these prices.

$6.00 each
5 for **$25.00**

Miniature

MERCURY VAPOR LAMP

Small and powerful. Ideal for indoor laboratory or outdoor examination of chemicals and minerals. Produces short-wave ultra-violet at 2537A and 1849A. Also provides pure green, blue, or yellow light (monochromatic) when used with the low-cost filters we have available. Use this lamp for testing optical flats, lenses, mirrors. Complete hook-up instructions with each lamp.

Standard Mercury Lamp	6 for	**$11.00**
Extra Powerful Type	6 for	**$14.00**

STANDARD ARMY SNOOPERSCOPES

Brand new, complete with new 1P25 tube. Coated optics on front lens. Contains in addition a built-in infra-red light source. Less battery power pack and rear eyepiece (a simple eye loupe works fine). Priced at a fraction of original government cost. **$150.00**

SNOOPERSCOPE BOOK

Shows all the snooperscopes—American and British; German and Dutch tubes; optical and electrical arrangements. The most specialized book on infra-red we have ever seen.

SALE PRICE **$1.00**

MAKE THINGS GLOW IN THE DARK!

ULTRA-VIOLET LAMP

Screws into any lamp socket. Emits violet and ultra-violet light. The argon gas in these lamps makes minerals and chemicals, etc., fluoresce. Priced at less than wholesale cost!

100 for **$25.00**
50 for **$15.00**
15 for **$ 5.00**

CHEMICALS THAT GLOW IN THE DARK!

FLUORESCENT CHEMICALS

Brightest glowing, basic concentrated phosphors, no inert ingredients. Available in many colors. Red, White, Blue, Green, Yellow, and Orange. Mix with clear lacquer for painting.

only **$5.00** per pound
6 pounds of assorted colors only **$27.00**
1 ounce assorted color kit **$3.00**

SPECTROSCOPE

Instantly identify rare gases and many minerals and chemicals. Displays a brilliant spectrum of the complete visible range. Compact pocket-type instrument. Excellent clarity of lenses and diffraction grating resolves the principal dark absorption lines in the solar spectrum.

Sale price at only **$12.00** each

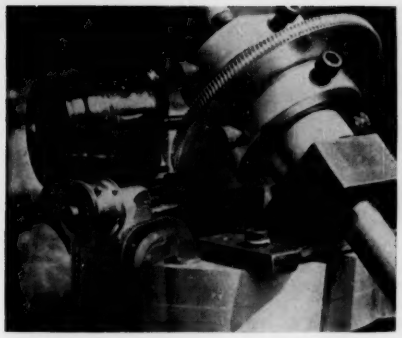
CESIUM VAPOR LAMP

The most efficient source of near infra-red light (the most sensitive range for snooperscope tubes). 100-watt lamp emits 5 times more infra-red than a tungsten lamp.

Bargain priced at only **$20.00** each

Send Check or Money Order

PRECISE MEASUREMENTS COMPANY 942-S KINGS HIGHWAY, BROOKLYN 23, N. Y.
ES 5-9435



The west side of the tripod head of the Foltz refractor carries the 6-volt motor and the drum, with ratchet, to which the driving weight is attached.

by dew on the objective, although it has formed on the eyepiece.

Along the side of the main tube is a long bar carrying a counterweight, which is used to balance the telescope when my 35-mm. or 2¼″ x 2¼″ reflex camera is attached in place of the eyepiece. The finder is a war-surplus 10x telescope.

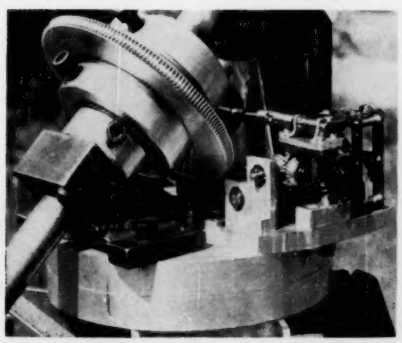
A piece of aluminum 8″ in diameter and ⅞″ thick forms the top of the tripod. Three pieces, each ⅞″ x 2″ x 4″, are bolted to its under side as hinge plates. Fastened to the hinges are the tripod legs, which are ¾″ seasoned cherry. The two sections of each leg are held together at the bottom by a 5/16″ bolt.

The clock drive on the tripod head was partly based on Mr. Sweger's note in the April, 1954, Gleanings for ATM's, and is partly my own idea. A lead weight powers the drive, which is governed by an alarm clock speeded up until the minute shaft rotates once every eight minutes. One end of this shaft carries a worm which drives the 180-tooth main gear, and its other end extends beyond the polar axis to a drum holding the cable to the falling weight. A ratchet on the end of the drum allows rewinding the cable after it has reached the end of its run.

To this basic clock I have added a small differential, which provides slow motion in right ascension. Coupled to the differential is a 6-volt reversible motor powered by a hot-shot battery. Thus with a small reversing switch I can guide my telescope from the eyepiece. This will be a great convenience when I try some serious photographic work. The clock may be regulated in a few minutes to run at a solar, sidereal, or lunar rate.

This drive has become very popular with South Bend amateurs as it is cheap to make, rugged, and dependable, and as it is independent of electrical outlets for power it can be set up anywhere. My installation can run for 2½ hours, and objects have been held in the field of a 300x eyepiece for over an hour without guiding.

RICHARD FOLTZ
916 S. 25th St.
South Bend 15, Ind.



On the east side of the polar axis are seen the driving-mechanism gears, including the differential for variable guiding speeds.

Everything for the AMATEUR TELESCOPE MAKER

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ALUMINIZING
Superior Reflecting Surface, Fine Finish, Will not Peel or Blister.

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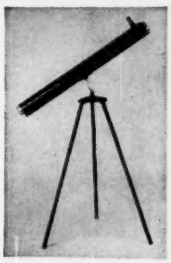

SKY-SCOPE
COMPLETE AS ILLUSTRATED $29.75

The full 3½-inch diameter reflecting type astronomical telescope that even the telescope makers talk about.

It has been sold for more than 15 years and now is on display in at least two U. S. planetaria. It will show mountains and craters on the moon, Saturn's rings, Jupiter's four moons and the planet's markings, and close double stars with guaranteed observatory clearness. Skyscope enjoys worldwide distribution.

Every instrument, with its ¼-wave, aluminized mirror, is individually tested before being packed for shipment. We suggest that before buying you inquire at almost any local astronomy society, about the efficiency of Skyscope.

We invite your attention to our free and straightforward descriptive brochure which also shows a photograph of the individual parts used.

125-power and 35-power extra eyepieces ..... $5.15 each
Six-power finder, with brackets $7.50
Holder for extra eyepieces $1.00

THE SKYSCOPE CO., INC. 475-s Fifth Avenue, New York 17, N. Y.

SKY - GAZERS EXCHANGE

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MOUNTED 5″ and 6″ refractor objectives of first quality, $200.00 and $300.00. 4″ edged blanks, $22.50. Correspondence invited. Earl Witherspoon, Sumter, S. C.

EQUATORIAL MOUNTINGS for telescopes up to 4″ in diameter, $12.95. Here is a good mounting for either a refractor or reflector telescope at an unheard-of low price. Mountings for 5″ to 8″ reflectors, $67.00. Gizara Instrument Co., 29 Trinity Place, Amsterdam, N. Y.

AMATEURS—Does your reflector perform as it should? If not, send it to us. We will refigure, aluminize and quartz coat it and return it with a pyrex elliptical diagonal for a reasonable price. Cave Optical Co., 4137 E. Anaheim St., Long Beach 4, Calif.

FOR SALE: Excellent professional 12½″ f/7 pyrex mirror in two piece cast aluminum cell, diagonal, rack-and-pinion holder with three eyepieces, and tube. $250.00. Frank Bender, Escanaba, Mich.

CALCULUS! Learn the easy way by playing new card game AQ. Four different decks: differential, integral, fundamental, and applied. $5.00 complete, postpaid. Copyrighted. Pocock Laboratories, 810 Sunset Lane, East Lansing, Mich.

UNITRON MODEL 142, 3″ equatorial, perfect condition, one year old. $350.00. Contact J. V. Plottner, 1202 44 St. N. W., Canton, Ohio.

COLOR SLIDES, 35mm. (2″x2″) of Mars drawings showing color changes in 1954, a Mars globe showing 1954 details seen by ALPO observers, Jupiter and Saturn drawings. Actual Kodachromes of the moon. All originals. Large selection. Free lists. Sample slide 30c. D. P. Avigliano, 678 W. Manzanita, Sierra Madre, Calif.

6″ EQUATORIAL telescope as illustrated in Laboratory Optical Catalog No. 5, page 7, and described on page 15. Complete except for remote indicating circles. $1,800.00 f.o.b. Plainfield, N. J. Stanley Brower, R. D. 2, Bound Brook, N. J.

10″ f/8 PARABOLIC mirror and cell. One year old, never used, made by Garth Optical Co. Cost $150.00 and $35.00. Will sacrifice both for $125.00. Edgar Matheny, 2626 N. Moreland Blvd., Cleveland 20, Ohio.

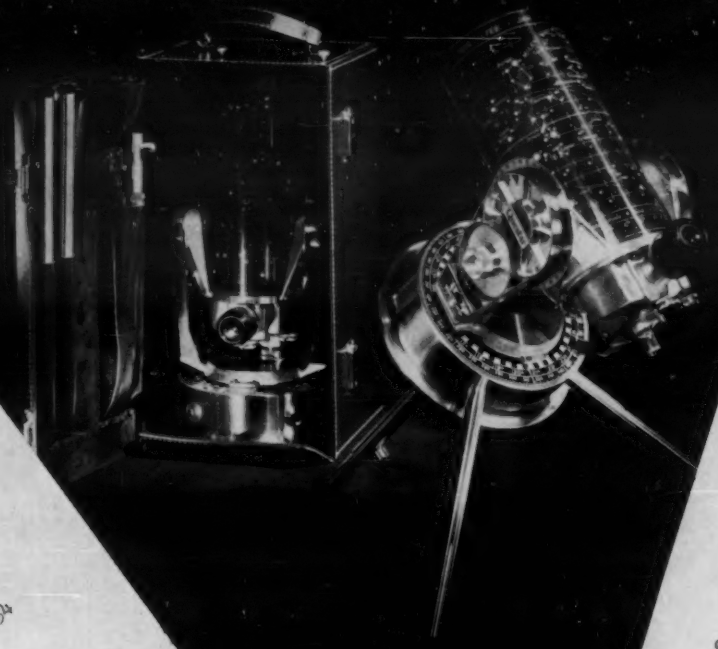
FOR SALE: Brass rack-and-pinion eyepiece holder, 2″ movement. Takes standard 1¼″ eyepiece. Price, $5.95 postpaid. Money back guarantee. Send check or money order to Donald Lehr, 31 S. Hood Ave., Audubon 6, N. J.

FOR SALE: 5″ refractor, excellent definition. Includes 7-power finder, sturdy tripod, accessories. $295.00. Take binoculars or ? part trade. Photo on request. Bill Brayton, 5123 Eagle Rock Blvd., Los Angeles, Calif.

FOR SALE: New 10″ mirror, 63″ focal length. This is a No. 1 mirror with very high resolving power. Aluminized and overcoated. $130.00. Mirrors made on order, prices sent on request. Reuben Borrud, 812 3rd Ave. W., Williston, N. D.

NORTON'S *Star Atlas and Reference Handbook*, latest edition 1954, $5.25; Olcott-Mayall, *Field Book of the Skies*, $5.00; Wilkins, *Our Moon*, $2.75; *Bonner Durchmusterung*, $100.00. All domestic and foreign publications. Write for list. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

FORTHCOMING PUBLICATIONS: *Amateur Astronomer's Handbook*, *Observational Astronomy for Amateurs*, both by Sidgwick; Vaucouleurs, *Physics of the Planet Mars*. Orders accepted. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.



J. M. BARKER
7447 SKOKIE BOULEVARD
SKOKIE, ILLINOIS

November 19, 1954

Mr. Lawrence Braymer
Questar Corporation
New Hope, Pennsylvania

Dear Mr. Braymer:

The Questar which I bought of you in September, 1954, is the latest in a long line of binoculars and telescopes which I have used over the last forty years. I should say that the advantages of Questar which impressed me most, after its superb optical qualities, are its very light weight and compactness, the ease with which its magnifying power can be changed, the remarkable way in which the electrical drive is designed to follow celestial movements without adding to the bulk of the instrument, and the perfection of its workmanship. The fact that the light weight of the instrument is concentrated so near its center of gravity, together with the stability provided by its tripod base, means that the "dancing" of celestial images due to outside influences is reduced almost to zero. You can see from the foregoing that I am very much pleased with the Questar both for celestial and terrestrial use.

Very truly yours,

J. M. Barker

CAVE OPTICAL COMPANY
4137 EAST ANAHEIM • TELEPHONE 34-2613
LONG BEACH 4, CALIFORNIA

Questar Corp.
New Hope, Penna.
Mr. Lawrence Braymer,

Dec. 1,1954

Dear Mr. Braymer:

This letter is to inform you of my findings regarding the quality of the Questar Optical system. We set up the coated front lens and aluminized mirror in the test rig, mounted it a few nights ago and examined image quality under actual conditions on the stars.

We are simply amazed at the perfect optical performance of the system. Star images give the perfect Airy diffraction pattern without the chromatic spread(Secondary spectrum) so common in even the best refracting telescopes. Double stars down to the Dawes's limit for the aperture were easily separated and if "seeing" conditions had been really good the night we observed the Dawes limit would have, I am sure, been exceeded. The Planet Jupiter showed a wealth of fine detail, and the Questar showed at least as much as a good 4" refractor.

The really nice feature of the telescope is its extreme compactness and its superb performance which makes it a telescope truly of the future.

Most cordially yours

Thomas R. Cave Jr.

Thomas R. Cave Jr.
Pres. Cave Optical Co.

P.S. We are returing the front lens and aluminized mirror, also several more perfect spherical mirrors.

☆Questar is a beautiful and compact 20th-century telescope of great power and versatility. Its long list of patented improvements, developed during 8 years of research, make Questar revolutionary in design and performance.

All Questar's advantages stem from the ultra-compactness of its unique design. For Questar literally frees the telescope from the 18th-century form into which it has been frozen, and lifts from the telescope the ancient burden of sheer bulk and weight that has made it so awkward to set up and use, and so difficult to carry and store.

Questar's superb new optical system embodies the first basic discovery in telescope optics for the last 200 years. It excels refractors of like aperture by the absolute absence of spurious color, and it is superior to reflectors by its spiderless closed tube construction and the perfection of its images over a wide field.

The photograph cannot show the deep blue jewel-like color of the engraved enamel-filled perpetual star chart, but it does indicate Questar's honest engine-turned aluminum and stainless steel.

In altazimuth form Questar travels as shown at the left, free-standing in its fitted case, fully assembled and always ready for instant use, a complete 12-pound portable observatory in ½ cubic foot. With images normally erect, rotary barrel, inclinable eyepiece, and built-in car attachment, Questar is the most versatile, convenient, and powerful terrestrial viewing scope of all time. It is a perfect 42-inch telephoto lens. With internal focusing to as near as 7 feet, it is the world's first long-distance microscope, a previously unknown and thrilling instrument.

The polar equatorial mounting raises Questar above a table-top to fit a person seated in the relaxed attitude of study, where in total comfort the well-nourished eye actually sees more. Electrically driven, with 6-inch sidereal clock, setting circles, clamp, fast and slow motions, the elegant Questar has every refinement of great instruments. It delivers the rock-steady image of a massive observatory telescope, yet weighs but 7 pounds. Smooth automatic following makes group demonstrations delightful. Solar work at regular class hours is safe and distortionless, with the first filter in history that keeps the sun's scorching radiation wholly outside the instrument.

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Daylight Observations of Planets and Stars

THE APPROACH of Venus to the sun during the November inferior conjunction was watched here when weather conditions allowed. For the benefit of others who care to observe this planet near the sun, it may be worth recording some of the difficulties encountered.

The instrument was a 10-inch reflector of 90 inches focal length, with a fork-type equatorial mounting designed and constructed by T. Whitham. Its setting circles are sufficiently accurate to locate an object in the one-degree field of view of the lowest power eyepiece, 60x.

The observatory is at latitude 55° N. Venus was difficult to pick up when near the sun, as with a declination of −22° the planet was only 13° above the horizon at meridian passage. The southern horizon here is over the smoky city of Newcastle upon Tyne. However, I was favored by several very clear mornings and was able to locate the rapidly diminishing crescent of Venus even on Sunday, November 14th, when the planet was about 4° south of the sun.

These observations were greatly helped by using a neutral-tinted moonglass to reduce the sky glare. I tried also stopping down the aperture, but the moonglass was better. Even so, it is essential to have the eyepiece marked so that the exact focus is obtained, for the slightest error in focus makes stars and planets quite invisible in daylight.

On the 14th, I first set the telescope on the planet at noon, but it was 12:30 UT before I actually saw that hairline crescent lying on its back. During the half hour I had been resetting the telescope and waiting for Venus to drift into the field, as I had no clock drive. I also checked the focus by picking up Vega and then again setting on Venus.

Once located, the planet could be kept in the field. I had hoped to see the ring of light produced by refraction in the atmosphere of Venus, but this was not observed. I called a friend and placed Venus for him to see, but it was some minutes before his eye could make it out. I was unable to look for Venus on November 15th, when it passed inferior conjunction.

I have seen Mercury with the unaided eye many times since 1921, but do not remember ever seeing it so brilliant as it appeared at 6:30 UT on November 15, 1954. I was able to follow it until 7:00 when it was swamped by dawn. In the telescope it was boiling so badly that the gibbous phase was difficult to make out. No doubt the great brilliance was due to the unusual transparency of the atmosphere that morning.

As a test for daylight observations of stars, R. A. Blackett and I in 1950 tried to find the faintest star visible in the 10-inch reflector in bright daylight, the method being to use faint companions of bright stars. The 5.1-magnitude companion of Epsilon Bootis was easily held at 14:20 UT on November 24th that year.

FRANK J. ACFIELD
Forest Hall Observatory
Northumberland, England

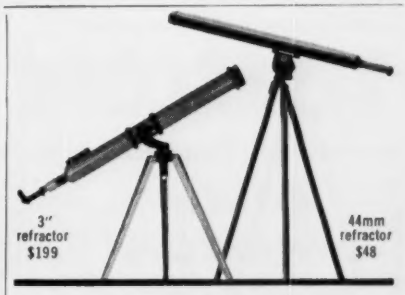
UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

MOON PHASES AND DISTANCE

Full moon	February	7,	01:43
Last quarter	February	14,	19:40
New moon	February	22,	15:54
First quarter	March	1,	12:40

	Distance	Diameter
February		
Perigee 2, 19h	229,100 mi.	32′ 25″
Apogee 15, 00h	251,200 mi.	29′ 33″
Perigee 27, 13h	229,500 mi.	32′ 21″
March		
Apogee 14, 21h	251,300 mi.	29′ 33″



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DEEP-SKY WONDERS

THE MESSIER objects that lie south and east of Orion are usually neglected by observers in our latitudes, yet three of the four we list this month can probably be seen with the naked eye under favorable conditions, and all are splendid sights in low-power binoculars.

The star cluster M41, NGC 2287, is at $6^h\ 44^m.9$, $-20°\ 41'$ (1950), about 4° south and west of Sirius. Visual estimates of its total magnitude range from 5.0 to 5.7, making it readily apparent to the naked eye. Well worth inspection with instruments of all calibers, the cluster consists of over 50 stars concentrated within an area about the size of the full moon.

Another open cluster, M50 or NGC 2323, is in Monoceros, with the 1950 coordinates $7^h\ 00^m.6$, $-8°\ 16'$. Its total magnitude is about 6.6 and its diameter is 16′. Webb's atlas shows a nebula about 2° preceding and 1° north of M50 which I have never been able to locate, nor does it appear in the lists that I have consulted. There is a finder chart for it on page 104 of the February, 1949, issue.

The 6.7-magnitude cluster M93, NGC 2447, is in Puppis, at the north edge of a great rift in the Milky Way. Its 1950 position is $7^h\ 42^m.5$, $-23°\ 45'$. Smyth's description as a "star-fish shape" is quite apt. Over 150 years ago the Chevalier d'Angos at Malta once mistook this for a comet, although even small modern instruments clearly show it to be a galactic cluster.

Also in Puppis, M46 or NGC 2437 is a galactic cluster at $7^h\ 39^m.6$, $-14°\ 42'$ (1950). Containing over 150 stars, its total magnitude is about 9. Messier described it as "enveloped in nebulosity." Modern telescopes do not show this, but Sir William Herschel did discover an 11th-magnitude planetary nebula near its northern border that Messier almost certainly could not see. This planetary is NGC 2438; H. D. Curtis, who studied it on photographs taken with the 36-inch Crossley reflector at Lick Observatory, described it as "a very irregular, broad, patchy ring 68" in diameter."

WALTER SCOTT HOUSTON

OCCULTATION PREDICTIONS

February 4-5 **g Geminorum** 5.0, 7:43.5 +18-37.3, 12, Im: **E** 10:46.3 +0.4 −1.9 140; **F** 11:11.1 +1.0 −3.2 174; **I** 10:30.6 +0.1 −2.9 162.

February 27-28 **Zeta Arietis** 5.0, 3:12.3 +20-52.7, 6, Im: **H** 5:53.1 0.0 −2.1 122; **I** 5:30.3 −0.5 −1.2 81.

March 2-3 **Mu Geminorum** 3.2, 6:20.2 +22-32.3, 9, Im: **D** 7:27.1 +0.1 −1.1 84; **E** 7:32.6 +0.1 −1.4 103; **F** 7:47.7 +0.3 −1.8 131; **H** 7:40.2 +0.2 −2.9 152; **I** 7:07.4 −0.6 −2.0 119. Em: **H** 8:23.9 −1.0 −0.2 240; **I** 8:09.2 −0.6 −1.4 270.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

VARIABLE STAR MAXIMA

February 1, R Corvi, 121418, 7.6; 1, V Cassiopeiae, 230759, 7.9; 6, RV Centauri, 133155, 7.6; 7, R Normae, 152849, 7.2; 8, T Ursae Majoris, 123160, 7.9; 12, Omicron Ceti, 021403, 3.7; 12, R Leonis, 094211, 5.9; 17, T Columbae, 051533, 7.6; 21, RU Sagittarii, 195142, 7.2. March 5, S Ursae Majoris, 123961, 7.9; 7, R Phoenicis, 235150, 7.8; 9, S Canis Minoris, 072708, 7.5.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

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OCCULTATION OF A STAR BY VENUS

On the morning of March 8, 1955, observers in North America can witness an interesting very close approach of the planet Venus to the 5.2-magnitude star π Capricorni. From parts of South America the star will actually be occulted by the planet. According to predictions in the **Handbook** of the British Astronomical Association, the star will be hidden from 9:15 to 9:20 UT at Rio de Janeiro, and from 9:14 to 9:20 UT at La Plata, Argentina. Position angles at the points of contact will be, respectively, 48°, 292°; 44°, 276°. On this date the gibbous disk of Venus will be 17″ in apparent diameter.

The occultation of so bright a star by a planet is a very unusual event. Disappearance takes place at the bright limb, so that the planet's glare will interfere. But careful observation of the time of reappearance at the dark limb, and of how long the star requires to recover its full light, might yield interesting information about refraction and extinction in the atmosphere of Venus.

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SKY PUBLISHING CORPORATION

Harvard Observatory, Cambridge 38, Mass.

SUNSPOT NUMBERS

November 1, 1, 0; **2**, 1, 0; **3-4**, 0, 0; **5**, 5, 0; **6**, 7, 7; **7**, 8, 8; **8**, 7, 7; **9**, 24, 24; **10**, 40, 36; **11**, 35, 44; **12**, 42, 38; **13**, 32, 37; **14**, 19, 23; **15**, 12, 9; **16**, 2, 7; **17**, 0, 7; **18**, 0, 7; **19**, 2, 7; **20-24**, 0, 0; **25**, 2, 0; **26-30**, 0, 0. Means for November: American 8.0; Zurich 8.7.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Melpomene, 18, 9.8. Jan. 23, 10:00.7 +8-40. Feb. 2, 9:52.1 +10-03; 12, 9:42.4 +11-35; 22, 9:32.7 +13-06. March 4, 9:24.3 +14-30; 14, 9:17.9 +15-38.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1955.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MINIMA OF ALGOL

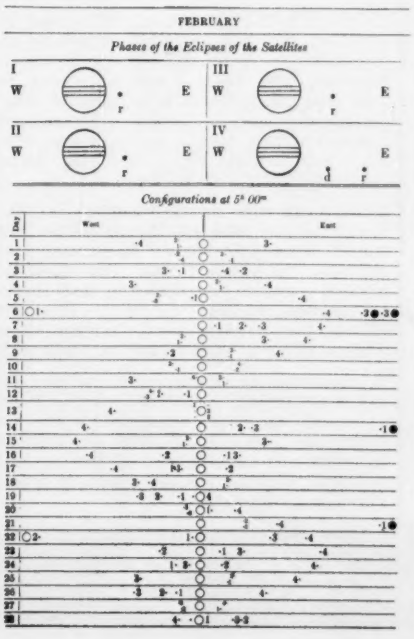
February 2, 20:46; 5, 17:36; 8, 14:25; 11, 11:14; 14, 8:03; 17, 4:52; 20, 1:42; 22, 22:31; 25, 19:21; 28, 16:10. March 3, 13:00; 6, 9:49; 9, 6:38.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac.*



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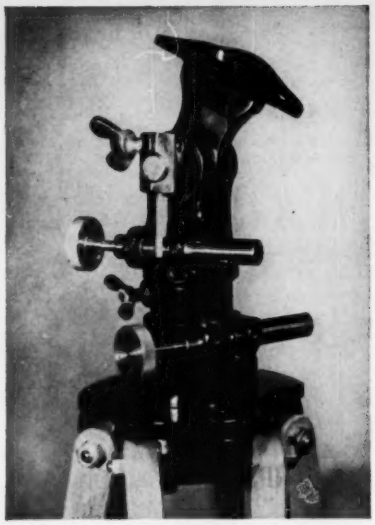

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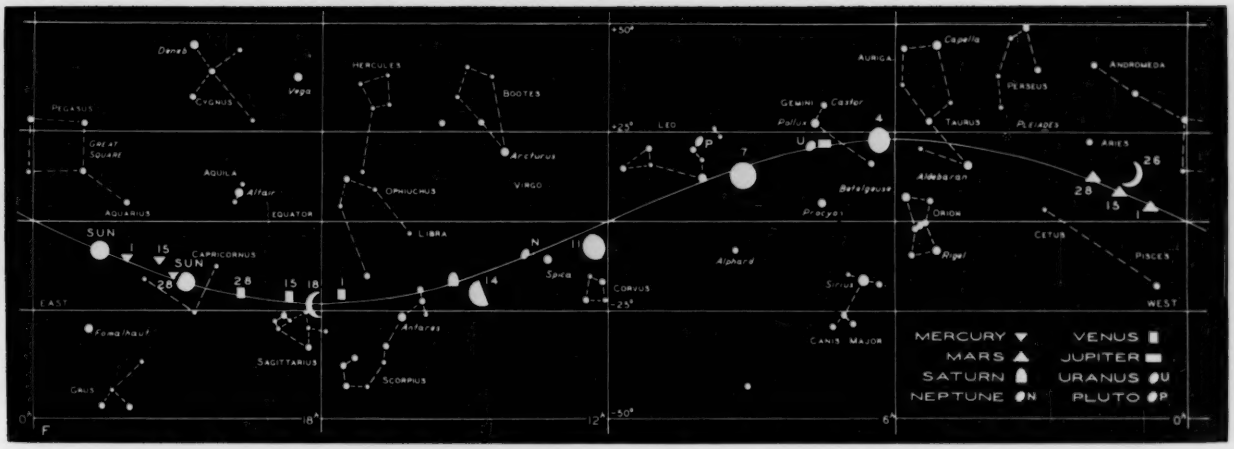


THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury may possibly be observed in both the morning and the evening sky this month. For the first few evenings in February, it is a 1st-magnitude object setting about an hour after the sun. After inferior conjunction with the sun on the 12th, it passes into the morning sky, rising an hour before sunrise at month's end, again at 1st magnitude.

Venus, which was at greatest elongation in the morning sky last month, will appear closer and closer to the sun until September. On February 15th, the planet rises 2½ hours before the sun. It will then be of magnitude −3.9, with a disk 20″ in diameter whose area is 60 per cent illuminated.

Mars continues its rapid eastward motion, with the sun slowly gaining on it. The red planet crosses eastern Pisces, and enters Aries at the very end of the month; it is conspicuous as the only 1st-magnitude object in this region. Mars is in the western sky after sunset, reaching the horizon some four hours later.

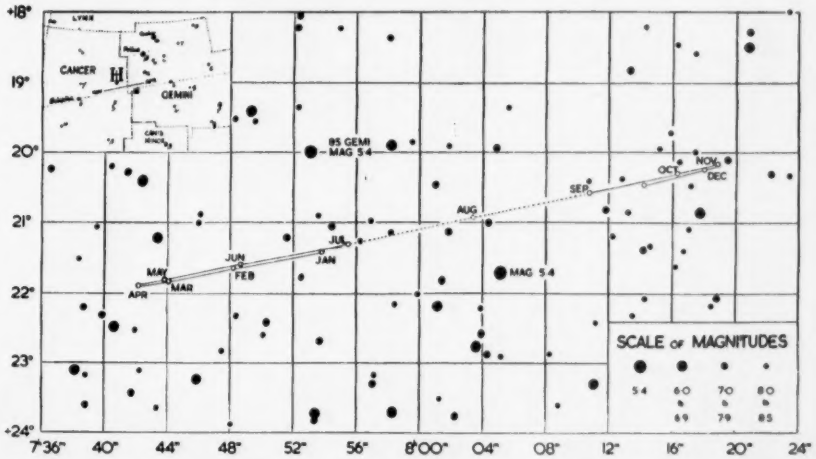
Jupiter will be high on the meridian about 10 p.m., south of Pollux in Gemini. Shining at magnitude −2.1, Jupiter continues its retrograde motion. The disk of the planet, always an interesting sight in a small telescope, is 44″.7 in diameter on the 15th. Be sure to view Jupiter on the night of February 5-6, for three of its moons will be in transit or occultation from 3:39 to 5:55 UT. (This is 9:39 to 11:55 p.m. Central standard time.) Only satellite **IV,** Callisto, will be visible, near elongation and well to the east of the planet.

Saturn rises a little after midnight early in the month, as western quadrature with the sun occurs on February 10th. The planet is moving very slowly, for retrograde motion begins March 1st. At magnitude +0.7 on the 15th, Saturn is near the center of the four stars that outline the constellation of Libra. The rings continue to open up, and are inclined 22°.3 to our view in mid-February.

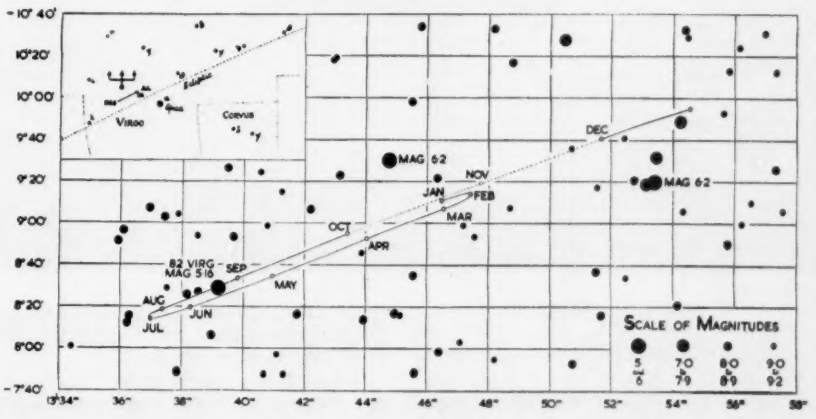
Uranus is in retrograde motion this month, about 3° east of Jupiter. At magnitude 6, Uranus is easily visible in opera glasses or a pair of binoculars.

Neptune rises about 10 p.m. in mid-month. Its motion is retrograde, as opposition in April is approaching. This distant 8th-magnitude planet may be seen in binoculars about 6° east of Spica in Virgo.

Pluto comes to opposition with the sun on February 15th, at a distance of 34.1 astronomical units from the earth. On this date its position is $10^h\ 6^m\ 20^s$, +22° 54′ 55″ (1950); these co-ordinates are changing by -6^s, +35″, per day. This 15th-magnitude planet is thus about 2° west of Zeta Leonis. E. O.



The path of Uranus among the stars in Gemini and Cancer is shown above; that for Neptune among the stars in Virgo, below. In each case the field is inverted, with south at the top, as seen in an astronomical telescope. The scales of the two charts are not the same. From the 1955 "Handbook" of the British Astronomical Association.



STARS FOR FEBRUARY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 5th and 21st of February, respectively; also, at 7 p.m. and 6 p.m. on March 7th and 23rd. For other dates, add or subtract ½ hour per week.

When facing north, hold "North" at the bottom; turn the chart accordingly for other directions. A good starting point for the beginner in constellation study is Orion in the south; another is the brilliant star Capella, nearly overhead at chart time.

Spitz Jr. Planetarium

No. 701 **Spitz Junior Planetarium.** A new visual teaching aid brings a knowledge of the heavens into your classroom or home. A plastic globe is perforated with small apertures and contains a pinpoint light source inside. Stars and constellations are projected on the ceiling; a dome is helpful, but not necessary. Adjustable for date and latitude. Size: 14½" high, 7½" square base. Weight 3 lbs. Operates on 110-volts. Complete with 32-page star guide. **Postpaid $15.00**

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No. 735 Here is the ultimate in the attractive display of celestial information in a fine furniture mounting. An accurate sky map, hand assembled, with white stars on a blue background is mounted on a 16-inch plaster ball. Full circle movable meridian is brass plated. A wide horizon ring contains degrees, hour circles, signs of the zodiac, calendar months, and days of the year. The solid walnut pedestal cradle has claw feet and stands 42 inches high. An interior 110-volt bulb makes stars stand out in true reality. Net weight 20½ lbs. **$104.50**

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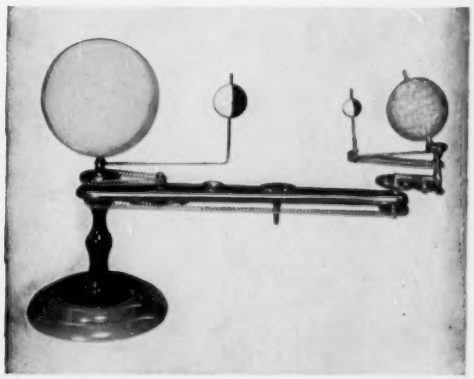
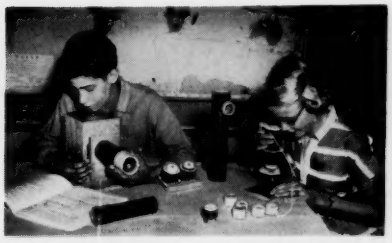


No. 708 This device demonstrates the relative positions and motion of the Sun, Earth, Moon, and Venus. Simplifies teaching rotation of the Earth, annual revolution around the Sun, day and night, change of seasons, and mechanics of eclipses. Brass with chain drive gears, hand operated. Arm length 16½", overall height 16". **$75.00**



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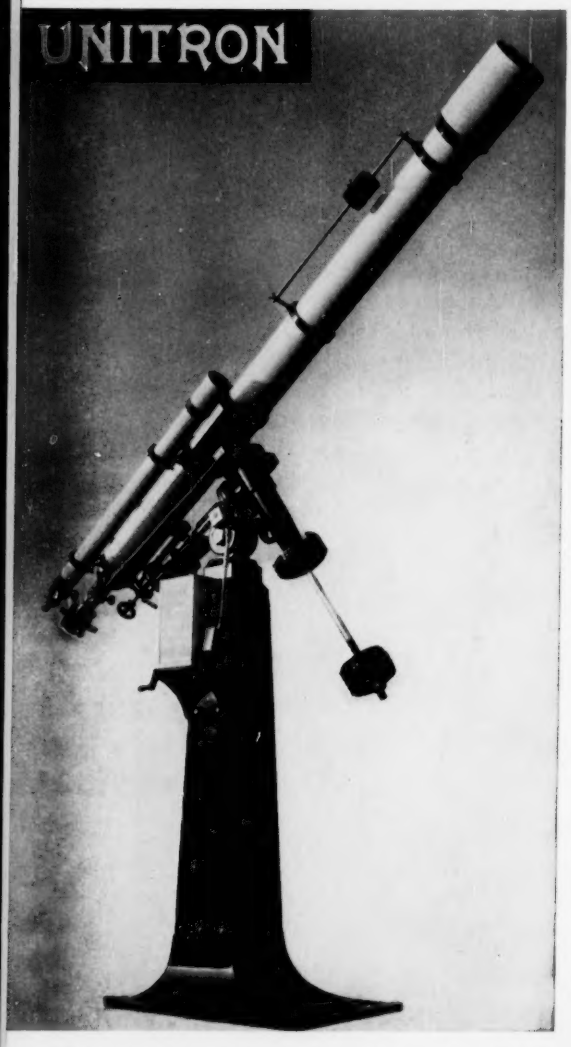
UNITRON

Prevues for 1955

An introduction to some new items that you'll be hearing a good deal more about in '55

It doesn't seem to be any secret that most telescopes of the "durable variety" sold these days are UNITRONS. What has, however, been a secret until now are the UNITRONS that haven't as yet been put on the market. Here we thought we would give you an inside look at some of the items that are currently occupying the attention of our research division.

We'll continue to keep you posted through these pages, and if you have written for our catalog on any previous occasion you will automatically receive by mail all forthcoming information as it becomes available.

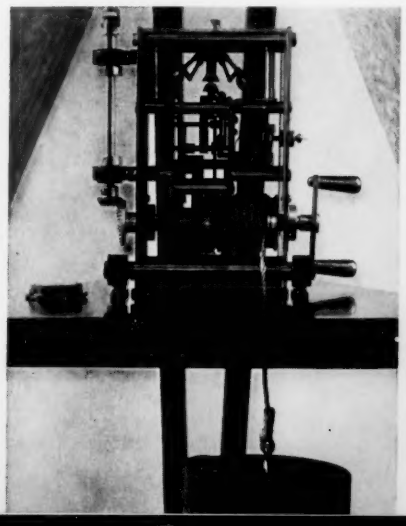


Pictured above is the first of a series of test models of a forthcoming UNITRON 6-inch Refractor, with pier and drive. This instrument will be a complete observatory installation and will incorporate every convenience for observing and for astro-photography. Auxiliary equipment will include a 3-inch guide telescope, a large view finder, two astro-cameras (not shown), about 10 eyepieces and a rotary eyepiece selector, and a spectroscope, as well as the standard UNITRON accessories.

Every UNITRON instrument offered is the culmination of extensive design and redesign, exhaustive testing and retesting, to preserve the distinguished UNITRON reputation.

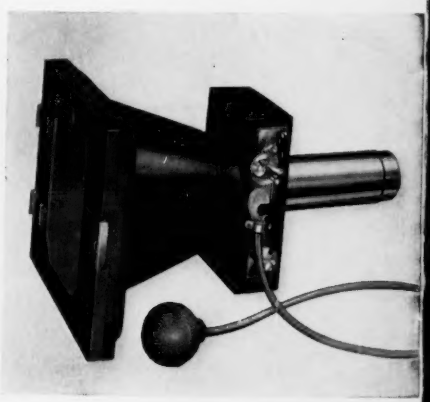
The tripod shelf on the UNITRON 4-inch Equatorial, Model 155 pictured above, has been found invaluable for holding eyepieces and accessories (as well as for storing a midnight snack for observers). It will also hold the neat little clock drive shown in detail below. This drive will also be used with the fixed pier we are offering soon for the 4-inch.

Attached to the Model 155 is the first of a number of astro-cameras that are in the works. This one (shown at the right) uses the objective of the telescope as the camera lens, with or without the eyepiece, for photographing the sun, sunspots, the moon, solar and lunar eclipses, and (with a clock drive) stars, nebulae, clusters, and comets.



Six magnifications at your fingertips! No eyepieces lost in the dark! Change eyepieces instantly while the object stays centered in the field of view! UNITRON owners will bless this accessory, which is described on page 168. When you want to change magnifications, merely rotate a new eyepiece into position.

At the moment, for temporary lack of a better name, we refer to this handy gadget as a "Rotary Eyepiece Selector." If you can think of a more appropriate name, preferably incorporating the idea of the six eyepieces, let us know. If we use your name, we'll send you as a gift one of these eyepiece selectors just as soon as they are available for delivery.



None of the new instruments and accessories is as yet ready for delivery. But as you know, there are already 9 UNITRON Refractors, which are priced on page 168.

Our catalog on these instruments is essential reading for telescope buyers, and is yours for the asking. Write for your copy to Dept. T-1.

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